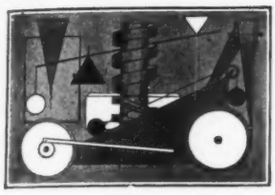
MACHINE DESIGN

as it affects

ENGINEERING–PRODUCTION–SALES

Volume 4 **September, 1932** **Number 9**



Forthcoming ISSUES

WOULD it not appeal to you if every major article in MACHINE DESIGN *could be torn out for filing purposes without tearing out with it the beginning or end of another article?*

E. C. Bullard of The Bullard Co. suggested to us some time ago that such an arrangement might be helpful to readers. Subsequent investigation confirmed his assertion and every effort therefore will be made in future issues to set up each article so that it can be clipped or torn out, if desired, without destroying other contributions.

L. E. Jermy

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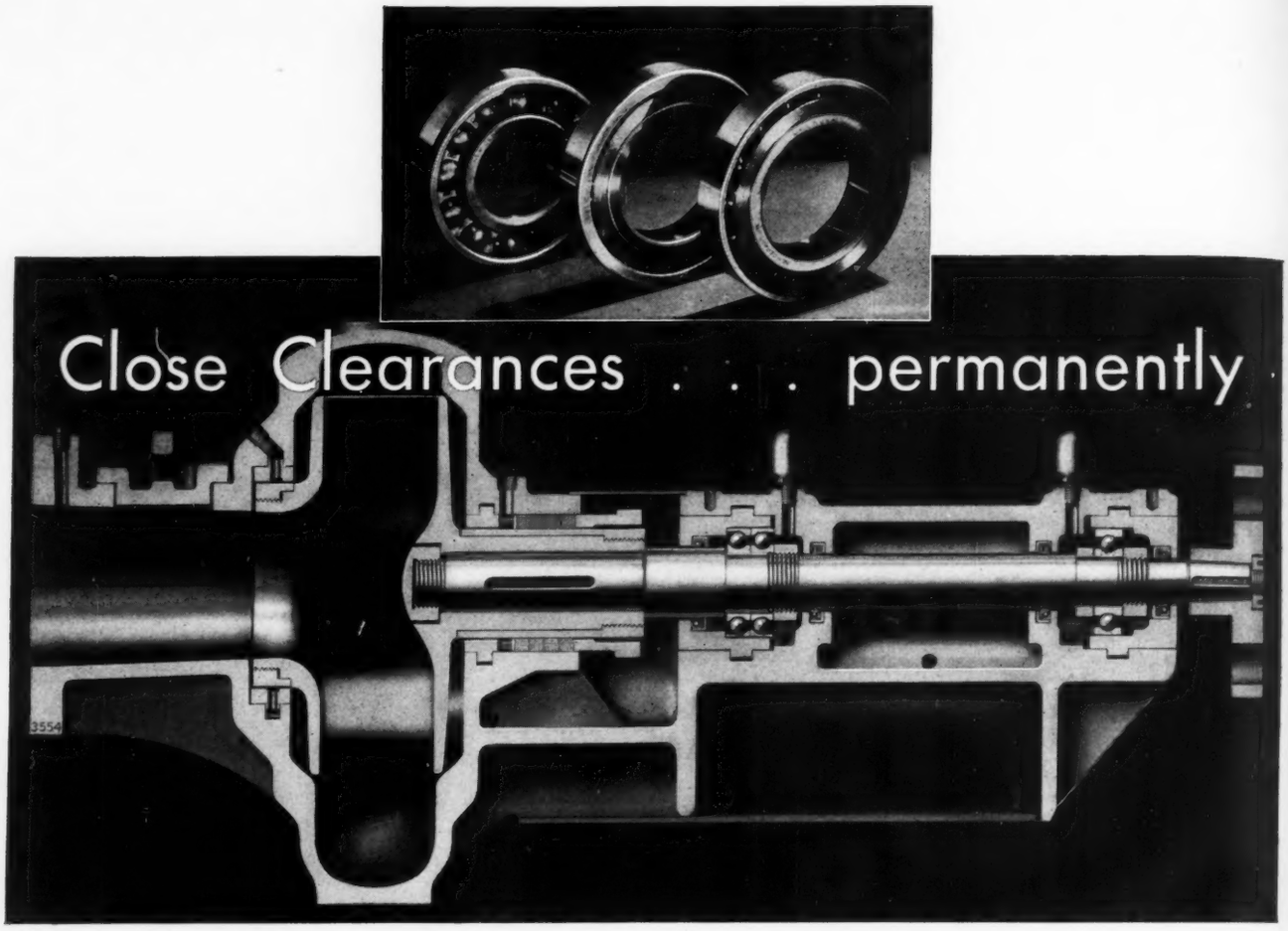

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NOTHING ROLLS LIKE A

NEW DEPARTURE BALL BEARING

1914

Itemized Index, September, 1932

Key: Edit, Editorial Pages; Adv, Advertising Pages; R, Right hand column; L, Left hand column

Compiled for the assistance of engineers confronted with specific design problems

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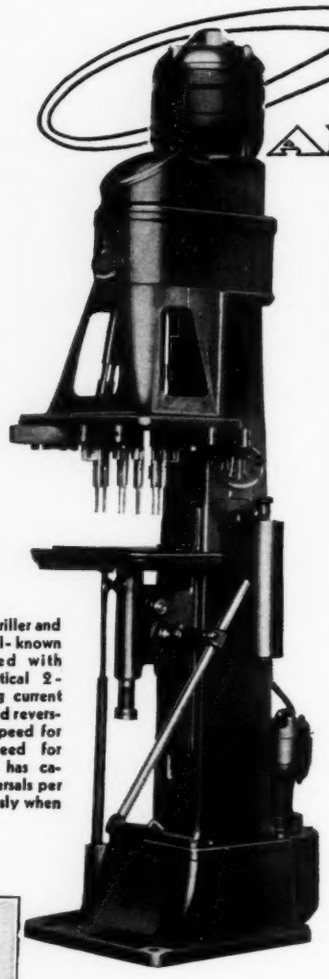

New Multiple Driller and Tapper of well-known make, equipped with Louis Allis vertical 2-speed alternating current squirrel cage rapid reversing motor; high-speed for drilling; low-speed for tapping. Motor has capacity of 50 reversals per minute continuously when tapping.

Previous design of Multiple Driller and Tapper shown above. An ordinary motor was used. Consequently, belts, pulleys, a shifter clutch, and tripping mechanism were needed to reverse the spindles.

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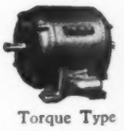
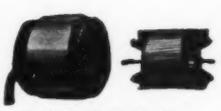

Torque Type

Standard Single or Multi-Speed

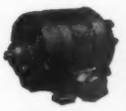
Self-Cleaning

Drip-Proof

Frame Type Shaftless


Rolled Shell Shaftless

Arbor Type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STANDARD AND CUSTOM BUILT MOTORS

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MACHINE DESIGN

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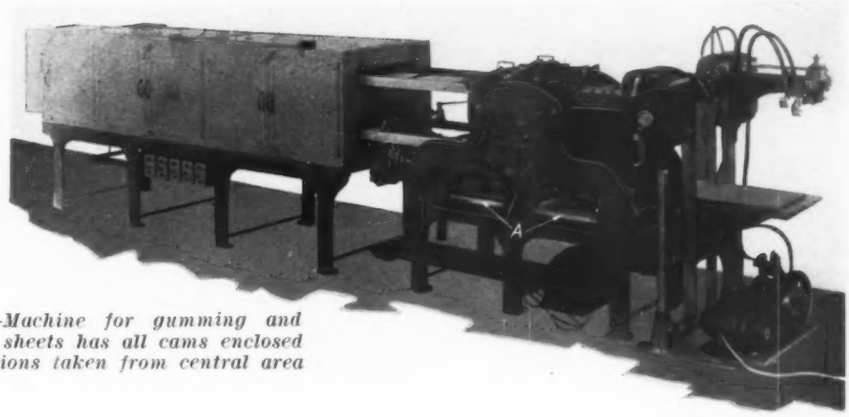


Fig. 1—Machine for gumming and packing sheets has all cams enclosed and motions taken from central area

Grouped, Enclosed Cams Aid Style and Efficiency

By A. Grimm

PRELIMINARY requirements, imposed when the finished equipment is still only an ideal, often present problems in design that are extremely difficult to solve. In designing automatic machines, for example, it usually has been customary to adhere to an open design, and to place the cams somewhere along the cam shaft and take off whatever motions are needed wherever it is most convenient. This method, which no doubt is less exacting so far as actual designing is concerned, could not be followed under the specifications for gumming and drying machines, described in the following, as they called for the enclosure of all gears and cam mechanisms in oil-tight housings.

Specifications also required that the machine be capable of an output of 2500 18½ by 22½-inch sheets per hour, properly gummed and dried, and be suitable for installation in the floor space occupied by the existing hand-fed equipment. Besides the requirement of housings over the cams, high speed shafts and shafts under heavy loads had to be mounted on ball bearings, and chains and sprockets properly protected.

The machines, built by Dexter Folder Co., Pearl River, N. Y., Fig. 1, consist of an automatic feeder with sheet conveyor and register mechanism, gum fountain, electric drier, and a dual delivery with air-operated packer.

Anyone who has had experience in completely enclosing mechanisms knows that it is not an easy matter to keep bearings of rotating or oscillating members oiltight, nor to design a housing so that the mechanisms are readily accessible for repairs and inspection as well as to have it oiltight at joints as required by the specifications. To attain these advantages, it was decided to cast the principal portion of the hous-

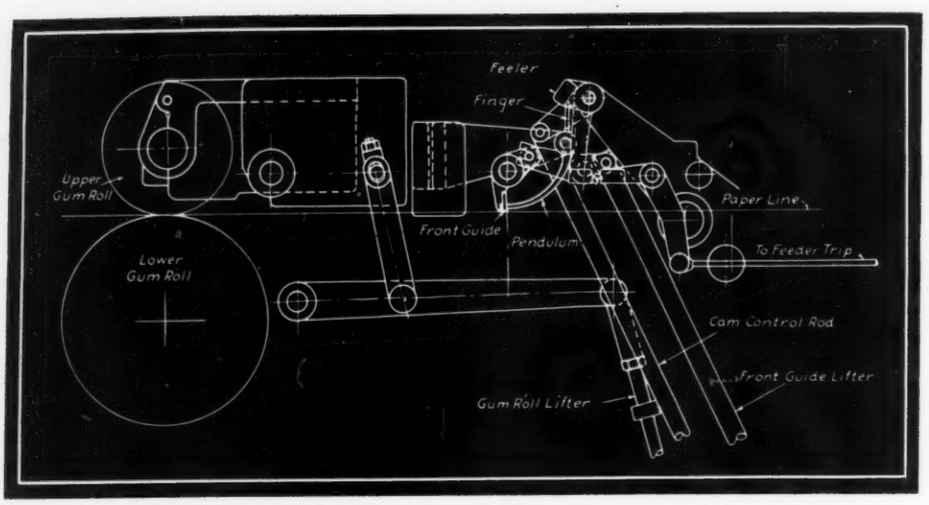


Fig. 2—Tripping device for gum fountain must be arranged so that it will not operate while a sheet is between the rolls

gears partly covered with old-fashioned gear guards

7. Machine is kept clean much easier and operator will take more pride in keeping it so than he would with a less pleasing design

ings, Fig. 3, left, in one piece with the upper part of the outer side and the top open, and the bottom forming an oil well, *A*. An intermediate bearing plate *B*, Fig. 3, right, is fastened to lugs extending from each side wall of the housing and this plate incorporates the necessary bushed or antifriction bearings. To complete the housing, a cover is put over its outer side through which only two shafts protrude. The top part of the housing is formed by a tight fitting hinged cover which can be raised during the operation of the machine for inspection or observation.

Unit Oil Seals Are Employed

To seal through-going shafts, commercial oil seals were installed at the point of their emergence from the housings. Oiling of the enclosed mechanisms is accomplished by means of a chain driven oil splash, Fig. 3, a method which is most suitable for enclosed design as it splashes oil, agitated by a special wheel *C*, over the rotating members located directly above the oil well which in turn transmit it to members higher up. It also creates an oil vapor throughout the housing which is sufficient to lubricate the bearings exposed to it and also some of the bushed rockshaft bearings. Bearings which cannot be reached by the splash, or would be lubricated insufficiently by the vapor, have oil cups placed so that they are accessible readily from the outside.

This type of housing construction has the following advantages:

1. Gears, cams, followers, cam rollers, etc., run under a constant spray of oil, thereby minimizing friction and wear
2. Number of parts to be oiled manually and time required to do so is reduced materially
3. Mechanisms function more silently
4. Accumulation of dirt and dust is eliminated
5. Possibility of oil dropping on the paper is excluded
6. Appearance of the machine more pleasing in that no running parts are exposed or

When operating, the sheet is delivered by the feeder to four tapes and two tape rollers set at an angle of two degrees with the center line of the machine which drive the sheet toward the side gage as soon as it is out of the bite of the

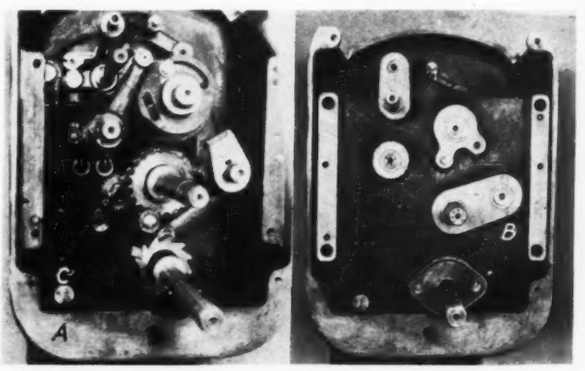


Fig. 3—(Left)—Principal portion of cam housing is cast in one piece. (Right)—An intermediate plate carries shaft bearings

drop rollers and register it sideways. Bearings on these rollers are mounted parallel to the center line of the machine and compensate for the angle due to their being of the self-aligning type. Cam-operated front guides locate the sheet in its proper position so that front and side grippers, Fig. 6 and 7, of the endless drier conveyor chain can take it off the feeder conveyor. Front grippers are of the tumbler type, while side grippers are of the breather type, that is, they are opened by means of stationary cams long enough to grip or release the sheet and then close again.

The sheet now passes through the gum fountain where the upper side receives a coat of glue about 0.001-inch thick. This gum fountain, Fig. 2, consists of an upper and a lower roll geared together to run at the same surface speed as the paper travels. A section is cut out of the lower roll to form a pocket which permits the front gripper bars to pass between the rolls, while the remainder of the periphery of this roll is equivalent to the length of the gummed part

of the sheet, there being a 1-inch margin at the front and a ½-inch margin at each side. The upper roll is made of monel metal and is mounted in a gum fountain with an adjustable scraper. This gum fountain is supported in a cradle connected to a tripping mechanism which automatically trips it in case of a missing sheet to prevent the lower roller from receiving glue.

While the feeder can be tripped immediately should it miss a sheet the gum roll cannot be tripped until the sheet going through has been gummed, thus making it necessary to adopt a delayed trip mechanism. To accomplish this tripping, a counterbalanced pendulum, Fig. 2, is suspended centrally from a cross shaft in front of the gum roll and projecting into the path of the sheet. A finger is fastened to the end of this shaft, and above it a cam-operated feeler is suspended. The sheet arriving at the front guides raises the pendulum and causes the finger to swing into the path of the feeler. This prevents the follower from dropping into the lower

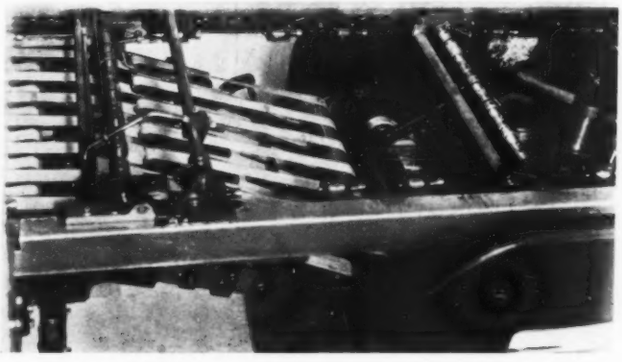


Fig. 4—Inclined tapes deliver sheets to the gripper mechanisms. Breaker rolls prevent curling

dwell of the trip cam and permits the gum roll to stay in its gumming position. Should a sheet be missing, the finger would not lock the feeler in place and the follower then would be permitted to enter the lower dwell of the cam and by means of a latch set the actual or delayed tripping mechanism of the gum roll. This delayed trip also consists of a cam, the follower of which is kept out of its lower dwell by a latch operated by the first trip cam, and it is so timed that the gum roll is not raised until the sheet going through has been gummed completely and is delivered.

From the gumming rolls the sheet is conveyed through an upper and lower chamber of a drying oven, being turned over between the upper and lower chambers so that it is facing down, gummed side on the bottom, at the point of delivery, a distinct advantage as this overcomes its tendency to curl up in the delivery box. It is, of course, imperative that at no time during its travel from the feeder to the delivery the sheet get out of control. Particular attention therefore had to be paid to the design of the mechanism which strips the sheet from the conveyor and transports it to the dual delivery.

Dual Delivery Required

The hand-fed machines have a so-called fly delivery which is emptied periodically by hand. However, this type of delivery would not work satisfactorily at increased speed, neither would it be possible to remove the gummed sheets with the machine running. Consequently it was necessary to design a dual delivery which would switch the sheets automatically from one box to another as soon as 500 sheets were delivered. The most difficult problem was to transfer the dried sheets from the conveyor grippers to the deliveries without permitting them to curl, thus causing a choke up.

This is accomplished by a delivery mechanism consisting of an inclined conveyor, Fig. 4, which reaches from the conveyor chain to the delivery boxes, the delivery proper and the air-operated packer mechanism. As the sheet approaches this inclined conveyor the front grippers are opened by a roller engaging a tumbler cam mounted on each gripper bar. The side grippers are opened consecutively as the sheet is stripped from the chain and guided onto the inclined conveyor. This conveyor is of the usual construction, having six bottom tapes running at a somewhat higher speed than the dryer conveyor chain, an equal number of top tapes and a tucker mechanism which tucks the sheet between the top and bottom tapes the moment the tumbler grippers open. At the lower end of this conveyor are located two breaker rolls which are

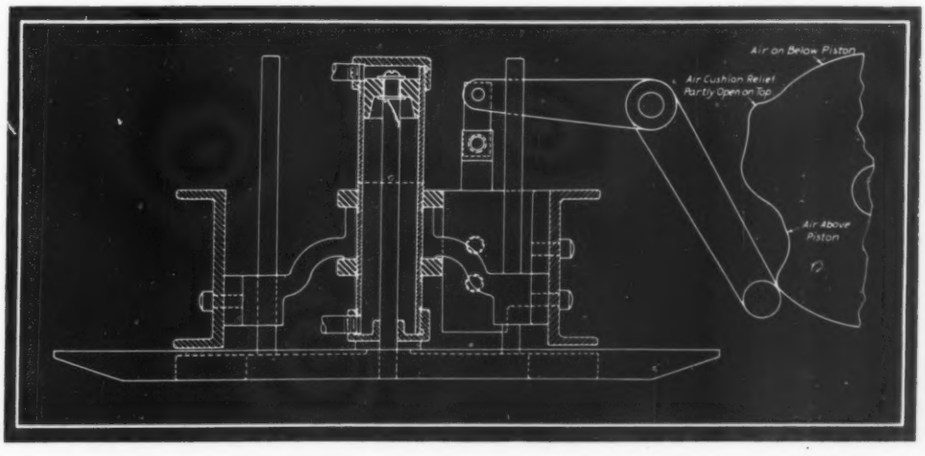


Fig. 5—Pneumatic packer compensates for differences in height of sheets in the boxes

used to break the dried gum sufficiently to keep the sheet flat. These rollers run at a considerably higher speed than the inclined conveyor because the space between the sheets while traveling through the oven in only 4½ inches, and this must be increased considerably

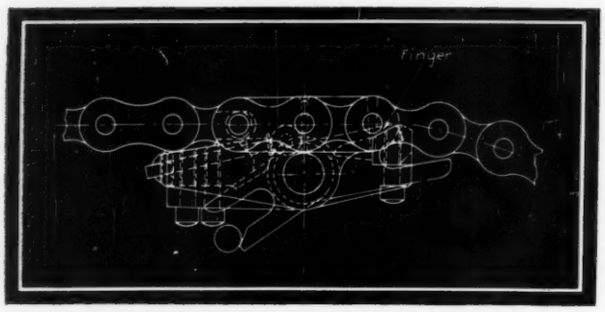
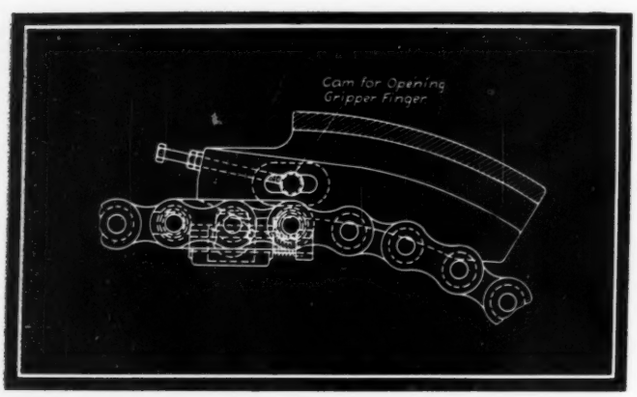


Fig. 6—(Above)—Front grippers are of the tumbler type, while side grippers, Fig. 7, (Below), are opened momentarily by cams



in order to gain time to permit the packer to operate. Coming from the breaker rolls the sheet is discharged upon two endless belts equipped with top tapes running at the same speed as the breaker rolls.

The dual delivery, adopted because of the increased speeds, consists of two individual boxes with pneumatically operated packers which receive the sheets as they are carried from the breaker rolls, shown at *A*, Fig. 1. At the start of the run the sheets are delivered into the first box, accomplished by interposing a stop plate at the end of this box. As soon as a sheet has come to a stop, the packer descends between the endless belts, pulls it out from under the top tapes and pushes it down into the box. The packer ascends immediately to permit the following sheet to come in. After 500 sheets have been deposited, the stop plate is raised automatically and the packer brought to a standstill, thus permitting the sheets to travel to the second delivery box. There they strike a permanent stop plate and are deposited in the box in the same manner by a second packer automatically put into operation when the first packer stops. The sheets in the first delivery box now can be removed at leisure without any interference.

Air-operated packers, Fig. 5, were selected in preference to mechanically operated packers for their simplicity and speed of operation as well as for the self-compensating feature peculiar to this type. The compensation in length of stroke of the packer is important in that it will descend less as the sheet pile in the delivery box increases.

Cams for operating the air valves for these packers are within the cam box which also contains the counting and switching mechanism. This counting mechanism consists of a pawl and ratchet arrangement which is operated at camshaft speed; the pawl really consisting of two pawls, one ½-pitch of a ratchet tooth longer than the other, so that for each stroke the ratchet is moved only ½ tooth, the distance of pawl travel, thus permitting the use of a smaller ratchet having comparatively deep teeth. The ratchet is connected to a worm and worm wheel which in turn operates a drum cam with a helix cut in it.

Directs Sheets to Second Box

Parallel to this drum cam a shaft is located on which are mounted two compression springs. These springs are separated by a sliding member which engages in the helical groove of the drum cam, one-half turn of which compresses the spring in front of the sliding member. The compression of this spring exerts pressure on a dog resting against a disk with two notches in it. This disk is mounted on the same shaft with the drum cam and makes ½ revolution for each 500 sheets. As the notch comes in line with the dog, the spring has been compressed sufficiently, and is released as the dog passes through the slot. This action throws a circular disk under the cam follower which operates the plunger valve, thus bringing the packer to a stop with the air pressure holding the piston in its upper position. This same action swings up the stop plate directing the sheets to the first delivery box and also releases the cam follower operating the air plunger of the second delivery box. The drum cam now starts on its return stroke compressing the spring at the back of the sliding member and thus repeating the operation.

During the design period, particular stress was laid upon designing the parts so that they could be machined readily or ground on the surface grinder without the use of fixtures or elaborate set-ups. With the exception of gripper parts there was not sufficient quantity to permit extensive tooling and, in order to make economical use of the surface grinder, as many parts as were practicable were kept of the same height so that the grinder table could be filled up. The drawings of these parts were cross indexed in such a manner that the shop had no difficulty in routing the parts so that they would arrive at the grinder together.

SCANNING THE FIELD FOR IDEAS

A Monthly Digest of New Machinery, Materials, Parts and Processes, with Special Attention to Significant Design Features and Trends

Vacuum Assists Refrigeration

EMPLOYMENT of familiar principles is the basis on which most technological development has been founded. A case in point is found in the recently designed vacuum refrigeration system which involves the principle that the temperature in a closed vessel containing water or steam depends upon the pressure. At high vacuum the temperature approaches freezing.

Advancement in technique employed in manufacturing processes often requires a continuous supply of cooling water at temperatures ranging from 32 to 50 degrees. This need is fulfilled successfully by the vacuum refrigeration system, Fig. 1. Manufacture of chocolates and explosives are examples of such processes, not to mention the rapidly increasing air conditioning field. Engineers of the Foster Wheeler Corp., New York, are the designers of the system. At the left may be seen the cold water discharge and the warm water return tank, the cooling cycle taking place between these two points. The operating principle is called "flash evaporation." Water to be cooled is piped into the flash chamber where a high vacuum is maintained.

The manner in which this vacuum is produced is well known. Steam passes through a group of high velocity steam jets in a thermocompressor, thus creating a suction in the flash chamber. This steam jet pump occupies a smaller space than that required for a reciprocating pump to produce the same amount of vacuum. The device operates on the same principle as that employed in evacuating vacuum tubes for X-ray machines by a mercury vapor jet.

A group of steam nozzles are directed toward an entraining throat, steam passing through attaining a high velocity. In the vacuum flash chamber a portion of the water evaporates, taking its latent heat from the water remaining. The vapors pass upward and enter the suction opening of the thermocompressor. At this point they are entrained by the streams of steam which compress the vapors and the actuating steam to a higher pressure, at which the condensing temperature is above that of the normal water supply.

Centrifugal Tail Pumps Remove Water

The thermocompressor discharges directly into a high vacuum condenser which in turn is served by a two-stage steam jet air pump that maintains the vacuum. Two centrifugal tail pumps are provided, one for removing the cooled water from the flash chamber and the other for removing the condensing water from the condenser.

A further advantage of the vacuum refrigeration system is that it can be employed as a heat pump where there is a demand for process heat. As a unit of this type it makes available for other purposes the heat removed from the

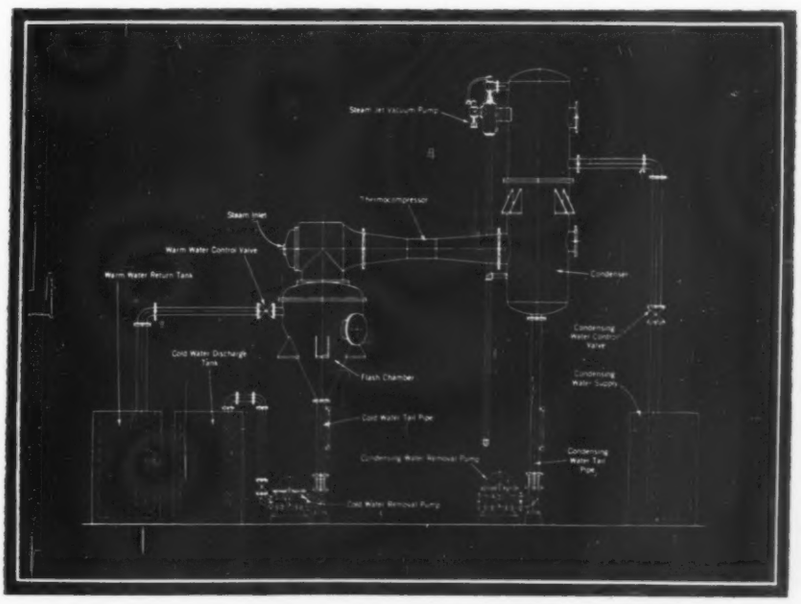


Fig. 1—Vacuum is employed in this refrigeration system involving the principle that the temperature varies with the pressure

cooled water by raising the temperature head of this heat in the compression of the vapors by the thermocompressor.

Whirling Disk as Surfacer

PEELING vegetables is a long, arduous task when performed by hand, but here again the designer has devised a machine which lifts the burden from hotel, restaurant and hospital em-

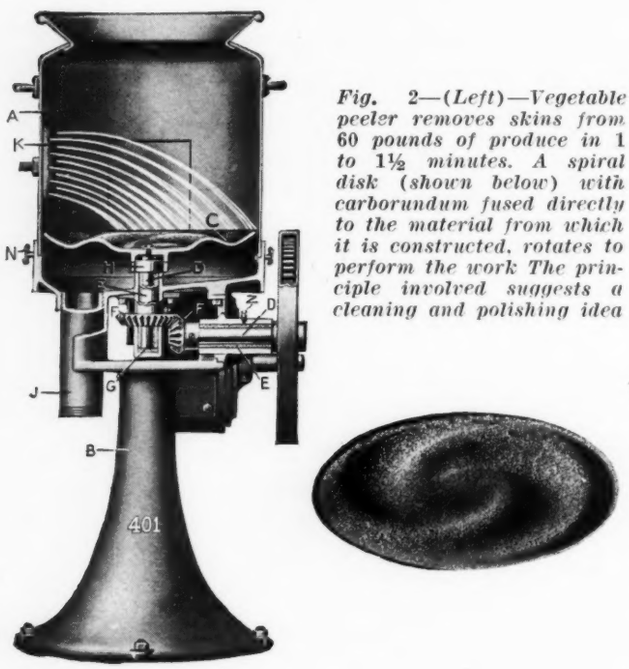


Fig. 2—(Left)—Vegetable peeler removes skins from 60 pounds of produce in 1 to 1½ minutes. A spiral disk (shown below) with carborundum fused directly to the material from which it is constructed, rotates to perform the work The principle involved suggests a cleaning and polishing idea

ployes. In developing a peeler an idea was incorporated which appears to have possibilities further afield, even to the cleaning and polishing of metal parts. The principle involved lends itself to this type of work, incorporating a spiral disk with carborundum fused directly to the cast iron while in the molten state, Fig. 2. Rotation of this disk does the work.

Vegetables such as potatoes, carrots, turnips, horseradish and other hard-root produce have their skins removed, leaving them smooth and clean and in their natural shape, by this machine manufactured by American Machinery Corp., Philadelphia.

Pearl Essence Augments Finishes

FINISH is the engineer's right bower! It is an accepted fact that mechanical soundness alone is not suffiicient to win market acceptance; both must be studied with care if the product is to impress the buying public. Pearl essence or "pearlescent," as it sometimes is called, is one type of finish that has caught the eye of the consumer. When it appeared on a well-known automobile some months ago it was an innovation. Now a refrigerator manufacturer is offering it in two colors, pastel green and silver gray.

The finish differs from conventional lacquers in that it registers a depth perception and resembles the gloss and luster of pearl. Iridescent qualities with changes in cast or color according to the light reflection when viewed from different angles form another characteristic. Before it was adopted for Servel refrigerators a lemon test was made to determine its acid-resistant properties. In a mechanical rubbing test using a stiff brush that made 129,000 strokes the lacquer did not wear out.

Pearl essence lacquer finishes employ as basic material a substance known as guanin, a silvery component in the skin of many species of fish. Guanin is rubbed off the fish scales, freed from foreign material, and suspended in a suitable liquid to form pearl essence which may be carried in a lacquer binder and applied in a manner similar to that used for ordinary lacquers.

Combining Two Units in One

VALUABLE development work is being carried on by manufacturers of systems for conveying and collecting process dust. Some extent of the progress being made is reflected in the design of a combined blower and dust collector condensed into a single machine, Figs. 3 and 4. In principle and performance this dynamical precipitator produced by American Air Filter Co. Inc., Louisville, Ky., differs from ordinary dust collecting fans.

Referring to Fig. 3, the impeller draws in the dust laden air or gas axially at the center inlet *A*. Heavier dust particles continue in a straight

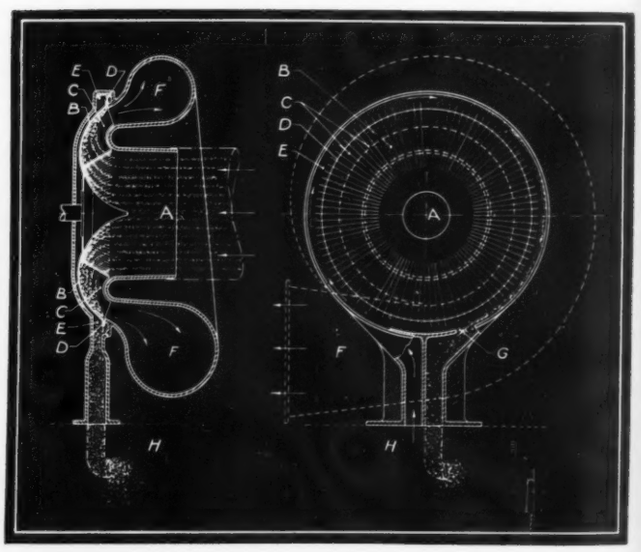


Fig. 3—Dynamical precipitator separates dust from air

line until intercepted by the supporting disk *B*, and then follow the curvature of its surface. Lighter particles that remain in suspension are intercepted by curved blades *C* which, due to

their unusual shape and rapid motion, cause the dust particles to be precipitated on their advancing surfaces.

Contour of the blades is such that the dust particles are moved outward by centrifugal force toward one point near the tip of the blade. At the point where both the heavier and lighter dust particles converge is a comparatively narrow annular opening *D* through which the dust escapes into a surrounding annular chamber *E*. The cleaned air or gas is discharged into scroll-shaped discharge *F*.

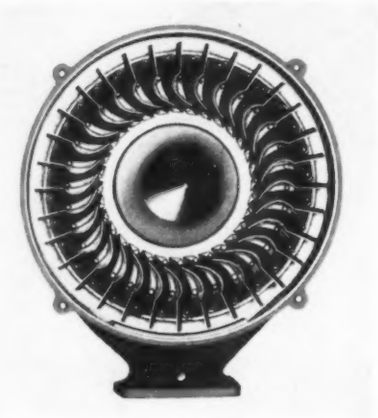


Fig. 4—Rotation of hyperboloid blades creates the necessary forces to draw in the dust laden air, separate and precipitate the dust and expel the cleaned air. The idea is indicative of a marked advance in compactness and simplicity in design

Dust is conveyed from the collecting chamber *E* by means of a secondary air circuit maintained by the prolonged tips of the impeller blades. These tips rotating in the collecting chamber cause the dust particles to follow the outside wall of the chamber to the point *G*, where a "skimmer" deflects the dust and a portion of the secondary air stream into hopper *H*.

Employing Magnetism in Track Brake

SAFETY and speed once were opposed but the engineer has changed this condition. With properly designed mechanical devices it now is possible to attain high speeds of revolution or travel without danger. This has been demonstrated by the Indiana railroad through the use of magnetic track brakes which operate in conjunction with and in addition to the air brakes on the cars.

The application of this type of brake suggests further uses on various types of equipment employing rails as track or even in cases where the moving part passes over, under or around a stationary member. In Fig. 5 are shown the shoe for the track brake, which is an elongated magnet with its poles parallel to the track, and the manner in which it is mounted on the truck of the rail car. Suspended by springs clear of the rails are four of these powerful electromagnets, one between each pair of wheels. The magnetic units are lowered into contact with the rails by small vertical air cylinders, contactors closing to energize the magnets from the trolley as the shoes drop vertically in guides.

When an emergency application of the conventional air brakes is made, either from the motorman's brake valve or the controller handle, air is admitted through a double check valve to the top of a relay, allowing it also to enter the air cylinders for lowering the magnetic brake shoes. Use of this type of brake manufactured by General Electric Co., provides an improvement in stopping distance and greatly reduces the effect of possible wheel slippage. Magnetic attraction in this form offers numerous possibilities in design for providing a positive method of curtailing speed.

Glass Piping Combats Corrosion

AND now glass pipe. Its transparency, cleanliness and adaptability in conveying hot or corrosive liquids fills a long felt need. Designers in the chemical, mining and food industries particularly, will be benefited by Corning Glass Work's Pyrex piping. Other fields also will find uses as engineers study problems that call for such properties as glass affords.

Handicapped at first by the lack of a satisfactory joint to hold the glass section together, the company's engineers developed an air and heat-proof compression fitting which could be assembled and taken apart without danger of breaking the glass. It is a wide flange metal collar with asbestos inserts which absorb the pressure of bolts and form a heat-resisting seal.

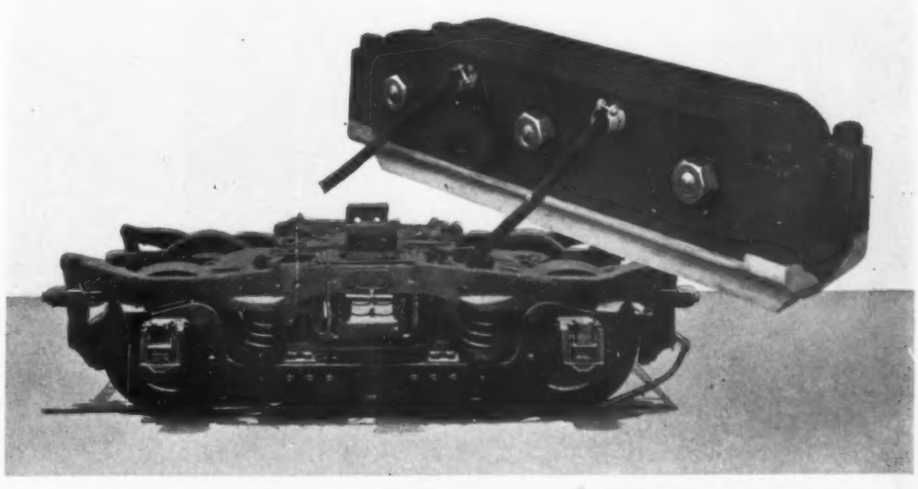


Fig. 5—Magnetic track brake employed on railroad cars possesses other possibilities

Design Is Safeguarded by

By H. H. Lurie

WITH the discovery of Roentgen, or X-radiation, so called because of its mysterious penetrating power, Prof. K. Roentgen, in 1885, opened to the analyst many avenues of investigation. The medical profession was the first to seize this valuable tool and apply it diagnostically as an aid in locating, treating and solving ills of the human body. In 1912, Laue, Friedrich and Knipping showed the electromagnetic nature of this radiation by its diffraction in passing through single crystals. Their work laid the foundation for the study of the X-ray spectrum, crystal analysis, atomic structure and the actual measurements of the wave length of X-rays. Later Debye and Scherrer, and almost simultaneously, Hull, developed the powder method, a simpler form of crystal analysis for testing many types of specimens.

From the above fundamental researches three types of X-ray analysis have been developed, all of which are applicable to the metal working industries. These are listed in the order of their popularity, ease of manipulation and cost of production.

1. Analysis by absorption—shadow pictures produced on photographic film (radiographs), or on a fluorescent screen
2. Interference patterns—photographs produced by diffraction of X-rays in passing through a single crystal (Laue pattern), or diffraction of monochromatic rays passing through many fine crystals (powder method of Debye-Scherrer, or Hull)
3. Spectral analysis—photographic record of the characteristic spectrum emitted by any material when its atoms are excited properly

Because of the difficulty of analysis, length of time required and accompanying high cost of producing emission spectra of metals, the method will be omitted in the discussion.

Of the three methods, that by absorption (radiography) is the easiest, cheapest and most readily analyzed. It is based on the fact that X-rays are absorbed by materials through which they pass in an amount almost directly proportional to the density of the materials. For X-rays of a given wave length it is more accurate to say that absorption increases with the atomic number of the element, i.e., lead, atomic number 82, is therefore a much better absorbent of the rays than aluminum, atomic number 13.

In radiography, if the metal plate is of uniform thickness and structure and free from defects the developed film will indicate this in the form of a uniformly darkened negative. However, if pattern numbers, gas pockets, shrinkage cracks or sand inclusions are present in the plate, these can be located readily in the developed nega-

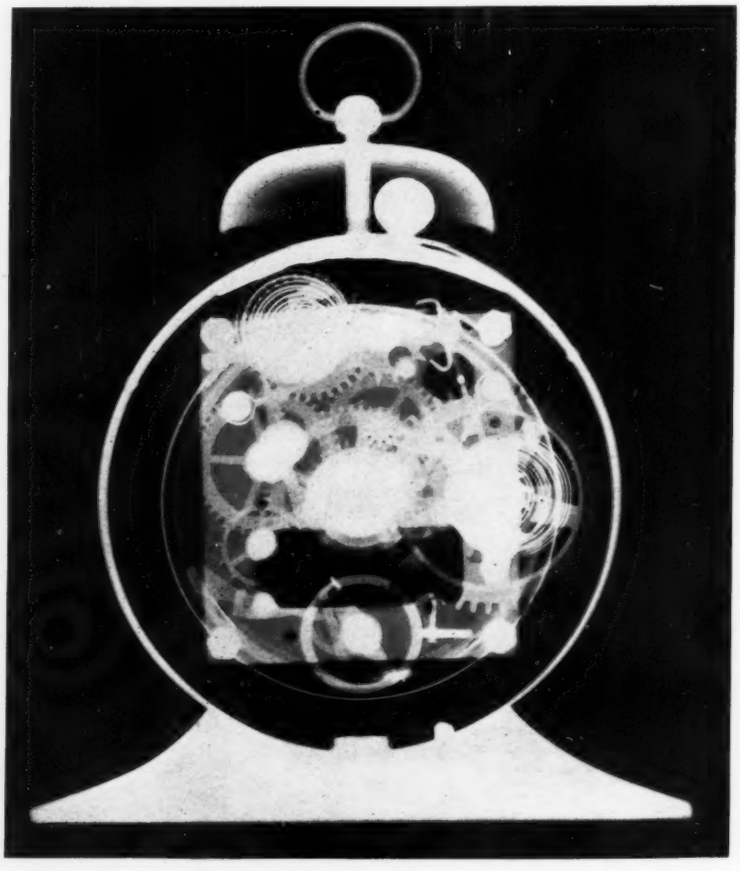


Fig. 1—Radiograph of a clock which indicates the way in which the moving parts are meshing

X-Ray Testing

tive. The denser portions such as bosses, pattern numbers, etc., permit less light to pass and consequently show up as lighter or less exposed areas in the negative. The less dense portions in a cast iron plate, i.e., gas pockets, shrinkage cracks, etc., allow more X-radiation to pass through and are manifested as darker areas.

The applications of this method in the field

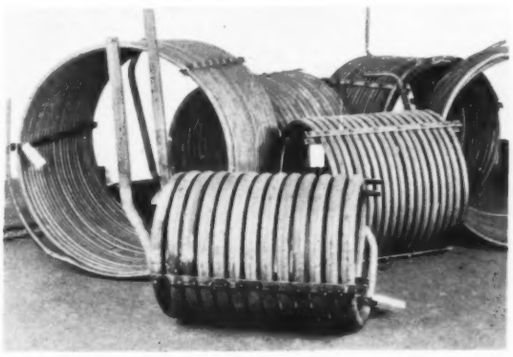


Fig. 2—Failures are averted by checking joints of superheater coils of butt welded tubing used for locomotive service

of metals lie in the detection of flaws in castings and welded structures subjected to high pressures or stresses, the alignment of enclosed intricate mechanisms, development of new processes and the correction of old methods of manufacture.

Brief Service Caused Failure

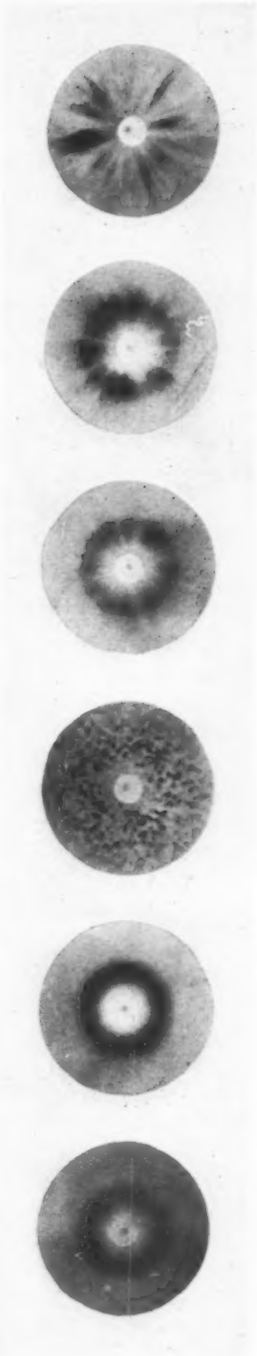
Fig. 4, left, shows shrinkage cracks and porosity in a cast steel automotive transmission housing in which failure due to fatigue in the weakened section usually occurred after a brief period of service. By changing the location of the risers and the method of gating, castings of the type shown in Fig. 4, right, were obtained. In this instance it was possible to improve the casting without altering the pattern in any particular.

The value of radiography in checking pattern designs cannot be over emphasized. In designing machine frames webs are added to give stiffness to the structure but these often are too thin in comparison with the frame proper. The thin sectioned web will chill quickly and tend to pull away from the larger body of metal in the frame which is still liquid or plastic. Shrinkage cracks then will appear in the web. Since cooling progresses inwardly the softest metal is inside the web. The shell of metal formed on the outside usually can withstand the stress of shrinkage while the inside cannot. Shrinkage cracks so formed are hidden and only a radiograph or fracture can uncover them.

By following each change in design, gating or pouring practice with a radiograph, a procedure giving sound castings and a minimum of scrap parts readily will be evolved.

At a well known motor plant a saving of $30,000 was effected in 60 days by the application of radiography to foundry methods. This sum includes a saving not only in the foundry by the reduction of scrap parts but also in the shop by the elimination of costly machining.

Fig. 3—X-ray diffraction patterns of 0.95 per cent carbon tool steel



It is not practical to maintain 100 per cent X-ray inspection of castings except where the parts are individual, intricate and involve expensive machine finishing; or where defective welds or castings may endanger life. The latter includes high pressure vessels or fittings and airplane parts. X-rays are so effective in locating internal defects that the boiler code of the American Society of Mechanical Engineers, accepted January 1, 1932, compels the radiography of every inch of welded seam in Class 1 pressure vessels.

In the manufacture of superheater coils for

ABILITY to see the reactions of materials and parts to the loads imposed on them is of tremendous advantage to the designer, who in this way can determine the points in the design that need strengthening. Flaws in castings also can be detected. Mr. Lurie is research engineer, Claud S. Gordon Co., Chicago.

locomotives lengths of seamless steel tubing are butt welded by the oxyacetylene process to produce a tube of sufficient length to wind the whole coil, Fig. 2. If one welded joint should fail, the cost of removing, repairing and remounting the coil in the boiler is approximately $300, or slightly more than ten times the cost of making a complete radiographic examination of all joints in any one coil.

A radiograph of one of the welded joints in which a pin-hole was found is shown in Fig. 6, left, indicated by the arrow at *A*. Fig. 5, left, shows the outside appearance of the joint cut out of the coil, while at right the actual hole can be seen on the inside of the joint at *B*. Fig. 6, right, is a radiograph showing sound metal throughout the rewelded joint.

Determines Alignment of Parts

Employment of radiography in determining the alignment of mechanisms is illustrated in Fig. 1, a radiograph of the dark-room timing clock. It should be borne in mind that much detail in the original negative is lost in its reproduction. For this reason printed copies of radiographs seldom are referred to in practice and their only purpose is for matters of record or illustration.

The second application of X-rays to machine design is by the use of Laue diffraction patterns. This method has not gained the popularity it deserves as yet, possibly because it is more expensive than the radiographic method and because the results obtained cannot be deciphered as readily as a shadow picture.

Briefly, a diffraction pattern is produced by passing a fine beam of X-rays through a thin sample of the substance under examination. In passing through the material, portions of the beam are reflected by various atomic planes or layers. These reflections produce images of the aperture from which the X-rays issue on to the sample. The shape and size of the images depend on the physical condition and the chemical composition of the material. Thus a material in which the crystals are comparatively large and under no pressure or strain will produce a dotted diffraction pattern of the type shown in Fig. 3*d*. The crystals of such a material are said to have "random orientation." However, if the material is under strain the crystals become distorted and have a forced or "strained condition." Metal of this type yields diffraction patterns such as shown in *a*, *b* and *c*, Fig. 3. Finally, when by much cold work or certain types of heat treatment the metal becomes hard and loses its ductility, the crystals are reduced almost to powder size and we obtain a pattern similar to *e* and *f*.

After the physical properties of a metal have been correlated with diffraction patterns it is possible to predict with some degree of accuracy the properties of a given sample. In Fig. 3 various steps in the processing of a piece of 0.95 per cent carbon tool steel are followed with diffraction patterns. Fig. 3*a* shows the metal in the ingot to be under partial strain not distributed evenly. A bar from this ingot passed through the cogging mill develops the structure shown in Fig. 3*b*. The crystals have been broken down to some extent but uneven strain still prevails. The steel next is sent through the rolling mill which further reduces the grain size and makes the strain distribution a little more uniform. This is shown at *c*. Due to the fine grain and great strain already placed on the rolled steel it would crack under slight forging. To relieve the crystals of strain and permit them to grow, the bars are given a careful anneal. Fig. 3*d* shows such metal which now is capable of being forged or cold worked to a much greater extent than when it was in any of the three preceding conditions. After the tool is machined or formed it is hardened. The fine, hard structure in the metal heated to 1450 degrees Fahr. and quenched in oil is indicated by *e*. If the tool is overheated to 1600 degrees Fahr. before quenching, as was the case in Fig. 3*f*, the metal may be burnt, develop cracks and have a nonuniform structure.

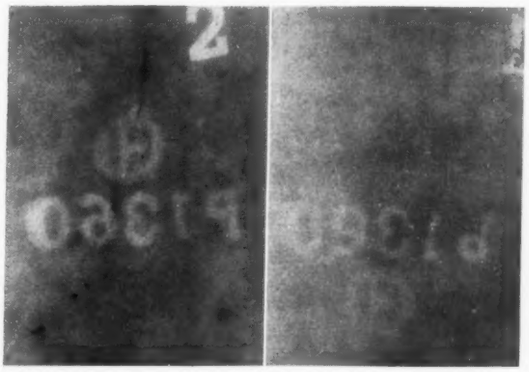


Fig. 4—(Left)—Porosity and shrinkage cracks in cast steel housing are revealed by radiograph. (Right)—Foundry practice in making the casting was changed from that shown at left to insure perfect castings

By use of diffraction patterns the condition of metals which produce failure of a part in the process of manufacture, or after brief service,

can be detected easily even though chemical analysis or metallography might fail. Only a small sample of the metal is necessary and when this has been etched down to a thickness of a few thousandths of an inch a diffraction pattern may be produced in from 5 to 20 minutes. Compare this with the several tedious procedures required in a quantitative chemical analysis of the metal, or sectioning and polishing the sample for a metallographic analysis. Hours if not days are saved!

'How and When' Are Important

A designer must not know merely what metals to use but also how and in what condition to use them. In forging a lever arm subjected to sudden stresses the fiber in the stock metal must run parallel to the length of the bar or direction of forging. The crystals should show little or no strained condition. In other words, the crystals should possess random orientation. The larger they are the greater their capacity for forging or other deformation. If the proper material is used and the fractured section shows no seams or segregations originating in the ingot, a diffraction pattern will tell quickly whether correct heat treatment was given the part or if a strained condition was carried over from the rolled bar or forging operation.

Another valuable application of diffraction patterns is in the checking of materials and methods used in producing deep drawn parts such as shells or covers. Almost any kind of thin metal will develop "ears," "stretcher strains" or cracks if drawn excessively between

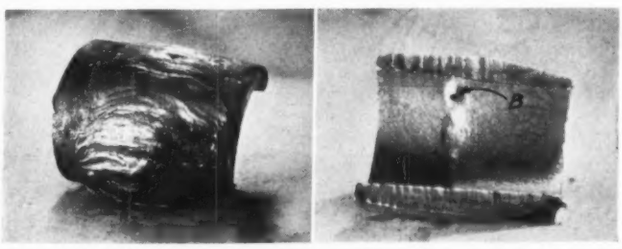


Fig. 5—(Left)—Hole in coil joint does not show from the outside while on the inside, (right), at B, it is revealed

annealing operations. The safe limit of elongation or reduction in area can be determined easily. When certain lots of the raw material produce acceptable products while others fail, the trouble usually can be traced to an improper condition in the sheet stock. That is, the metal was not furnished in the proper temper, or the thickness of the sheet was reduced too much in one of the passes in the mill. Metal in the latter condition, even if thoroughly annealed, cannot possibly return the crystals to a state of random orientation. Scrapping, remelting the sheet and rerolling is the only method of bringing the metal into the desired form.

Brass, copper and alloys containing zinc occasionally develop trouble in deep drawing operations which often can be overcome by changing the rolling mill practice. Of course in quantity production low cost is one of the most important items and attempts to eliminate annealing operations, or draw the metal excessive-

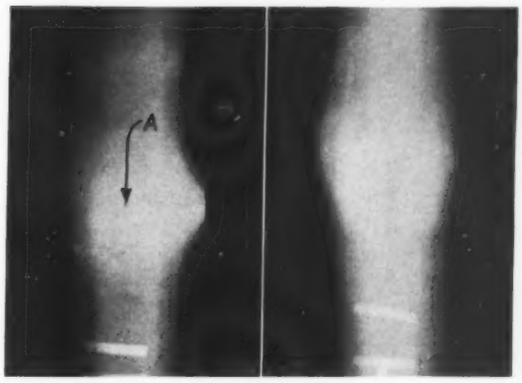


Fig. 6—(Left)—Radiographic examination disclosed the hole shown in Fig. 5. (Right)—Joint is rewelded to secure sound metal

ly between them, result in many scrap parts or a highly strained part which is easily fractured when in service.

Bibliography

W. L. Fink and R. S. Archer, "Radiography as a Tool in the Metal Industry," *Transactions of the American Society for Steel Treating*, October, 1929, *Vol.* 16. pp 551-590. (*Note: This article has appended an excellent bibliography of* 108 *articles and* 7 *reference texts*).

The Welding Engineer, April, 1932. *Vol.* 17. pp 35-37.

Few Patents Prove Profitable

ONLY 6 per cent of all patents find buyers and of this 6 per cent only 2 per cent are marketed successfully," according to G. M. Schucht, president of Schucht-Mier-Robertson Inc., Milwaukee. This company of consulting engineers has opened a new service which functions as a patent division for firms that cannot afford one of their own, and which supplements the facilities of the larger concerns. Mr. Schucht continues, "This means that out of every 10,000 patents granted, only 12 prove to be profitable for the manufacturer."

Relief from present conditions must come through the use of fact finding engineering methods, according to Dr. C. E. Skinner, assistant director of engineering for Westinghouse. He adds, "Costs of government have been mounting by leaps and bounds because so many projects have been either unsound or unecessary."

Balancing Slender Shafting

By J. L. Goldthwaite

ANY short rigid shaft is balanced easily by the methods used for crankshafts, and there are a number of instruments and balancing machines available for the purpose. But a long slender shaft, such as those on the U. S. S. AKRON where the motors are mounted inside the framework and the propellers on the outside, brings out additional problems because of its flexibility. In practice, a long shaft, if it is designed economically, is likely to be operating above its theoretical critical speed, according to Mr. Goldthwaite, assistant chief engineer, Allison Engineering Co., who presented the paper from which this article is abstracted, at the American Society of Mechanical Engineers Aeronautic meeting in Buffalo.

Balancing a long slender shaft is a difficult task. The ordinary methods based on reactions at the ends, do not apply, for the shaft may assume a different shape at each speed. It may be balanced nicely at one speed and yet vibrate badly at others.

Practical Solution Needed

Speaking of torsional vibration, is it too much to ask some practical mathematician to develop an analysis without the use of differential equations? I do not question the value of the mathematical method, but the subject of vibration is so extremely important that its treatment should not be restricted, as it is now, to specialists.

In Fig. 1, shaft *A* is shown diagrammatically with two units of unbalanced weight at the center; shaft *B* with two units also, but at the ends. At low speed, when flexibility does not enter, the end reactions of the two would be exactly the same; a balancing machine would not distinguish between them. Shaft *C* would show perfect balance. At high speed, however, it is obvious that the distortion of *C* would throw it out; and it is even conceivable that some speed could be found at which *A* and *C* would give substantially the same end reactions. It is necessary that each portion be in complete balance.

The longest single drive shafts of the AKRON transmissions are some 13 feet long, five inches diameter, with 3/16-inch walls. The first step toward balancing was to mount each tube on two bearings, turn it slowly by hand, and explore it inside and out, every six inches of length, with a dial indicator. Counterweights were calculated and applied to correct for unbalance due to eccentricity and variations in wall thickness; for this shaft was considered as being made up of four short lengths, and each length was calculated for complete static and dynamic balance.

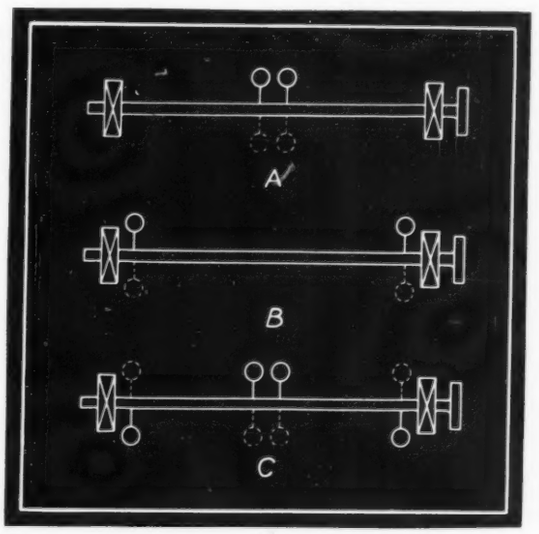


Fig. 1—Examples of shaft unbalance with the proper corrections shown by dotted lines

For final balance the shaft was mounted on three ball bearings on a long level bench weighing several tons, with clamps arranged so that any bearing could be held rigidly in place or alowed to move horizontally; the mass of the bench prevented vertical

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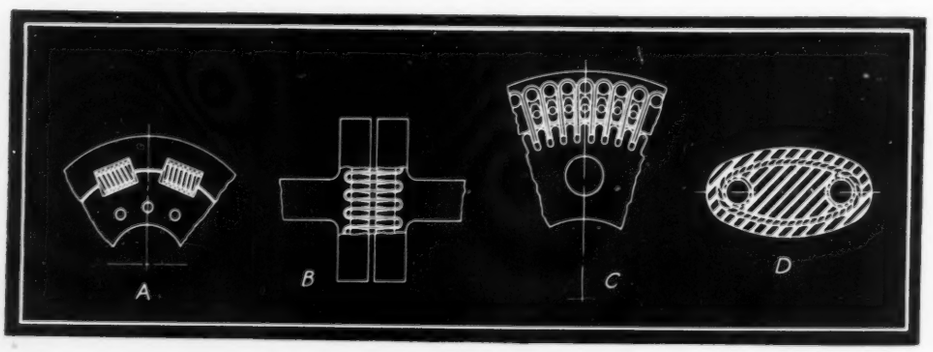


Fig. 2—Couplings allow for angular misalignment

Babbitt or Bronze?

Fig. 1—Dark formation in crystal is the hardest copper-tin formation

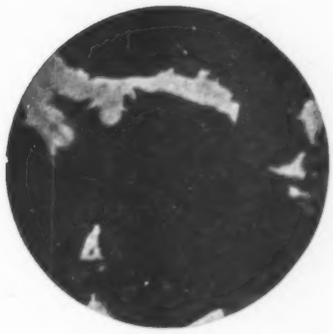


Fig. 2—Hard nickel-phosphor bronze crystal is non-eutectoid type

By C. H. Bierbaum

WHETHER a babbitt or a bronze should be selected always has been a perplexing question in machine design, if for no other reason than that there is available a series of both babbitts and bronzes, each specific alloy having its own special properties to recommend it. This, in itself, is adding to the complexity of the problem. There is no dividing line between the fields of application of babbitt and of bronze, they distinctly overlap each other. Therefore, the answer to the question "Babbitt or Bronze?" must be as involved as the question is complex. The subject can be considered best by subdividing into the factors which control selection: *Service requirements; metallurgy; mating member; design; workmanship;* and *lubrication.*

SERVICE REQUIREMENTS: In general, the babbitts, owing to their physical properties, are selected for the lighter service, and the bronzes are selected for the heavier service because of their greater strength. Babbitts are subdivided into lead base and tin base alloys. For the sake of economy the intermediate alloys, neither distinctly lead nor tin base should not be given any consideration. Lead base alloys should be chosen for the lighter loads, though they are suited equally well for high speeds. Tin base alloys, having the greater strength, are selected for the heavier punishments in babbitt service. For the heavier general service requirements, naturally, the bronzes are used and, in turn, the harder and stronger bronzes should be specified for the heaviest punishments. The tin base alloys have the distinct advantage of being suitable for sweating on to either steel or bronze backing. When the danger of melting out exists, a solid bronze bearing, or a thin layer of babbitt sweated on a backing must be used.

METALLURGY: The hard or bearing crystals in the ordinary bearing alloys as revealed by microhardness studies, may be considered in their increasing order of hardness. In a lead and antimony alloy consisting of less than 12½ per cent of antimony, its hardest crystal is the lead-antimony eutectic dispersed in a lead matrix. If, however, the antimony is in excess of 12½ per cent, its hardest crystal is metallic antimony dispersed in a brittle matrix of a lead-antimony eutectic. In a lead base babbitt consisting of lead, antimony and tin, with the antimony in excess of the tin, the hardest crystal is the tin-antimony crystal dispersed in a lead matrix containing varying amounts of lead-antimony eutectic. However, if the tin is in excess of the antimony the hardest crystal is likewise the tin-antimony crystal but dispersed in a matrix containing a percentage of tin-lead eutectic. A small percentage of copper added to the foregoing composition will make the tin-copper crystal hardest, leaving other conditions unchanged.

Hardest Crystals Described

The hardest bearing crystal in the tin base alloys consisting of tin, antimony and copper, is the tin-copper crystal and the next in hardness the tin-antimony crystal, both dispersed in a matrix of tin. In a bronze consisting of copper and tin, with sufficient tin to form the tin-copper eutectoid, this eutectoid constitutes the bearing crystal for the copper and tin bronzes dispersed in a matrix of tin-copper alpha solution. In a copper, tin and lead bearing bronze the same conditions obtain as before with this addition, that the lead is mechanically dispersed throughout the matrix. In the hard nickel phosphor bronze consisting of copper, tin, nickel and lead the hardest bearing crystal is the nickel-tin-copper ternary compound existing in a matrix composed of copper, tin and nickel with a mechanical dispersion of lead. The hardest of all the bearing crystals found in any of the bab-

bitts or bronzes is the compound $SnCu_3$. This compound can form only in a tin base babbitt containing a high percentage of copper under the condition of an extremely slow solidification. Bearing metals cannot be specified by chemical composition alone; their crystal structure should be given full consideration.

MATING MEMBERS: In all cases, the following two general conditions for bearing requirements should obtain as far as possible. In the first place, one member should possess the highest possible degree of microscopic homogeneity and the other a heterogeneity corresponding to that of a true bearing metal. Secondly, in no case should the hard or bearing crystals in a bearing be hard enough to prove distinctively abrasive to its mating journal, but should fall within that range of relative hardness in which the surfaces can mutually polish each other.

WHEN it is possible to secure two different metals for the same application, both of which will satisfy the requirements with but little difference in operating characteristics, it is difficult to choose between them. As there are many alloys of babbitt and of bronze, the choice of the proper bearing alloy is complicated. Mr. Bierbaum, vice president, Lumen Bearing Co., Buffalo, an authority on the subject of bearing metals, outlines controlling factors in this choice.

Babbitts, in general, are selected to mate with the softer steels, and the bronzes are chosen to mate with the harder steels. The softer lead base babbitts are selected for the softest or low carbon steels whereas the hard babbitts should be mated with the higher carbon or intermediate steels. The same considerations apply equally to the leaded bronzes; intermediate bronzes should mate with alloy steels and the hardest bronzes should mate with the harder alloy or heat treated steels. The one exception relating to the babbitts is that where the $SnCu_3$ crystal exists, this should always mate with hard alloy or treated steel.

DESIGN: Ample bearing areas should be provided. Where this is permissible the softer bearing metals and journals can be used, but in every case where economy of bearing area must be considered, harder bearings and correspondingly harder journals become imperative. The precautions relating to oil grooves, clearances and chamfering of edges apply equally to all bearing metals, namely: A proper amount of clearance space for a normal oil film should be specified and as far as possible all oil grooves should be parallel with the shaft and placed within the arc of minimum pressure. All edges of bearings and oil grooves should be chamfered in order to permit the formation of a supporting oil film. All unnecessary oil grooving or interruptions in the continuity of the oil film should be guarded against carefully. The outside diameter of bronze bushings should be specified so as not to produce an undue compression when the bushings are driven in. This diameter need be sufficient only to prevent looseness in the housing, with independent provision for fastening the bushing.

WORKMANSHIP: This is the one important factor that makes the production of satisfactory bearings possible. As the strength and hardness of the mating material are increased, the refinement of workmanship becomes correspondingly of more importance. The degree of accuracy of workmanship is frequently the deciding factor as to whether a babbitt or bronze should be used. The softer the bearing metal, the poorer the initial workmanship which can be toletated as long as journal and shaft can mutually polish each other. With poor workmanship life of the bearing, of necessity, is shortened. For the final finishing of bearing surfaces grinding is often resorted to, especially with the harder bronzes. Quite satisfactory results can be produced by this method if proper care is exercised to prevent any of the grinding material remaining embedded upon the bearing surfaces. This is especially important with the babbitts and leaded bronzes.

It not only is necessary that the surfaces should be true and accurately cylindrical but it is also important that the disturbed metal upon the bearing surfaces, incident to the tooling, should be as little as possible since all of the disturbed metal must be worn off before a true "run-in" surface can be established. The tooling of bearing surfaces therefore should be done with extremely sharp cutting edges having ample rake and clearance. Final cuts should be very light and preferably at a high speed. Modern diamond tooling upon the babbitted surfaces in crank bearings is an illustration of the contribution of workmanship to long bearing life.

LUBRICATION: This is important in that extremely few service conditions will give entire satisfaction without some lubrication. It often is claimed that the babbitts and the high leaded bronzes are more suitable under conditions of poor lubrication than the harder bronzes. This conclusion is not justified in its entirety if the harder bronzes are provided with correspondingly harder journals, or shafts with correspondingly high workmanship. One thing reasonably certain is that the harder bronzes, with proper design and construction, under poor lubrication will give a longer life than the softer bearing materials.

Hydraulic Transmissions in New Applications

By Carl Morey

Consulting Engineer, Big Rapids, Mich.

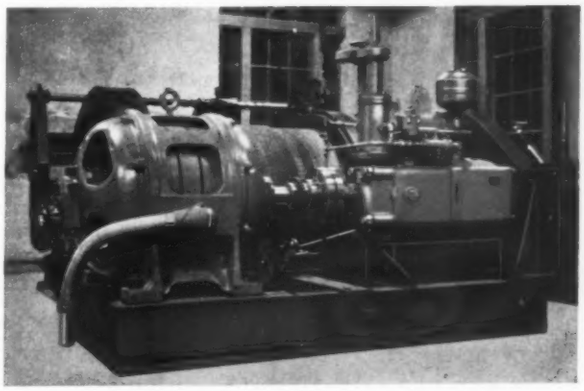
MANY factors have combined to limit the proper expansion of hydraulic drives, including consideration of high first cost without adjusting for length of life and economical operation, lack of knowledge of how these drives may be applied and what they can do, and lack of consideration of hydraulics in the original design. However, hydraulics should be considered more widely for hoists, equipment operating in explosive atmospheres, diesel engine drives, sequence operations and similar equipment where their advantages may far outweigh any disadvantages they possibly might have.

Since it can be accepted almost universally that all hoisting duties require high torque at starting, the variable displacement pump system is eliminated immediately for such uses except for special conditions. Fig. 1 shows one of these conditions. The illustration shows a type of hoist suited ideally for the purpose for which it is designed. The characteristics are interesting since the inertia of the load to be moved is such that low torque at low cable speeds is acceptable. This unit is in use on a mooring mast for large dirigible airships.

The prime mover consists of an 85 horsepower 430 revolutions per minute constant speed alternating current motor. This motor is direct connected to a variable displacement hydraulic pump which is piped to a constant displacement hydraulic motor. The combined units are rated at 80 horsepower for 24 hour service, and at 100 horsepower delivered at 400 revolutions per minute intermittent service. The hoist is capable of a cable load of 33,600 pounds at a speed of 50 revolutions per minute, and a light line load at 150 revolutions per minute.

Since the hydraulic motor is reversible, it is apparent that a full range of speeds is available in both directions of rotation. This characteristic is not essential in ordinary hoisting practice because paying out (overhauling) does not require an appreciable amount of power, if any. The control of the device is of the remote type, allowing the hoist to be operated from the head of the mooring mast.

With regard to the ordinary duties of hoists, it is preferable to design the system so that the motor displacement is adjustable or variable since this allows better torque characteristics, i.e., high torque at low speeds and low torque at high speeds. In the case of excavating machinery and cranes generally, this torque char-



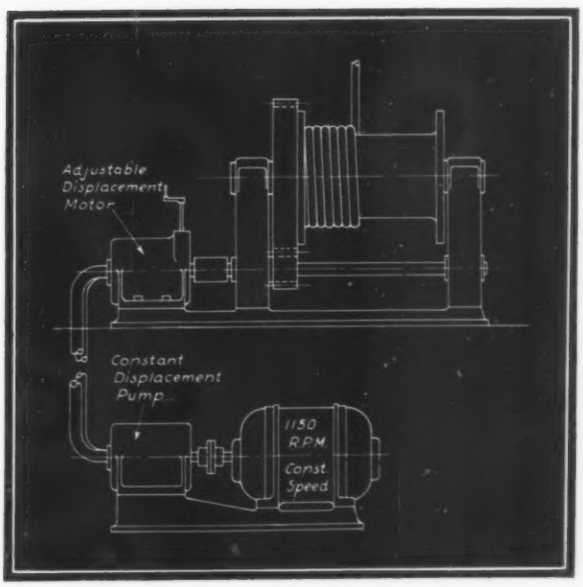


Fig. 1 — (Left) — Mooring mast hoisting unit, necessarily reversible, is driven by hydraulic motor. Fig. 2 — (Below) — Adjustable displacement motor and constant displacement pump makes a quite practical hoist drive

acteristic is indispensible in the operation.

Fig. 2 shows a practical system using an adjustable displacement motor and constant displacement pump driving a hoist. In this system the overloads are more infrequent which contributes to slightly higher efficiency. The layout is based on a 5 horsepower 1150 revolutions per minute constant speed alternating current motor. Allowing an overall efficiency of 60 per cent, the cable pull will be 99,000 pounds at 1 foot per minute, cable speed 9900 pounds at 100 feet per minute, and 990 pounds at 1000, which compares favorably with direct connected steam engine drive. There are many advantages secured by this type of drive, which include low priced electric motor and control, elimination of steam losses through condensation due to long pipe lines and leakage where the hoist is some distance from the boiler, simplicity of operation, and freedom from high maintenance expense.

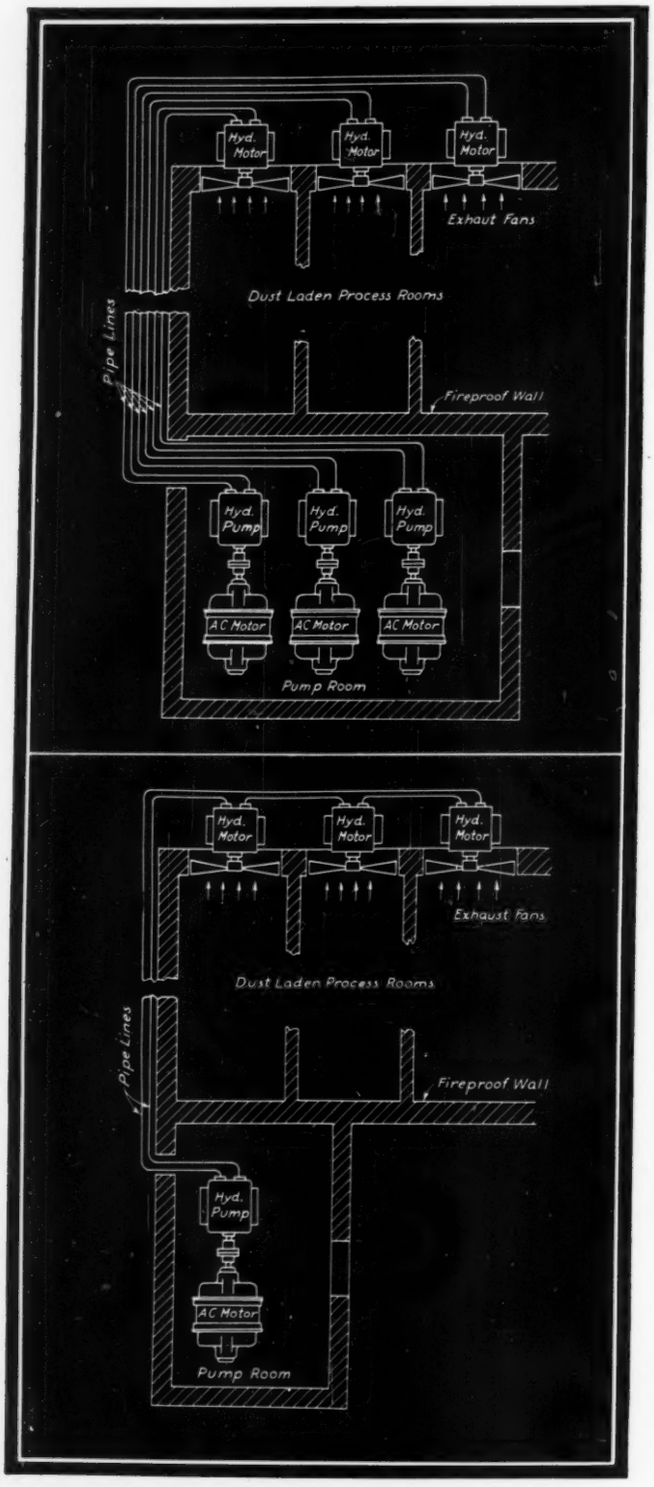


Fig. 3—(Top)—Hydraulic motors and individual pumps arranged to reduce explosion hazards in dangerous atmospheres. Fig. 4—(Bottom)—One pump used for three motors as contrasted with Fig. 3

Reduces Explosion Hazard

The possibilities of applying hydraulic drives to equipment used in plants, such as munition factories, flour mills, paint plants, etc., where commutator arcing or a loose terminal connection might cause a disastrous explosion incurring loss of life and property generally has been overlooked. Systems can be devised that will eliminate this risk and effect a marked reduction of insurance rates, etc. Hydraulic motors can be operated by individual pumps or, in special cases, several motors can be driven in series from one pump. Figs. 3 and 4 illustrate these two applications, the former using individual pumps, the latter using one pump only for three motors. It becomes apparent immediately that the pumps and electric motors can be placed at some distance from the motors, or in a separate building, and piped to the hydraulic motors.

Frequently it is necessary to purchase fully enclosed electric motors for operation where excessive dust, dirt or moisture is present. Due to a lack of proper motor ventilation, larger motors are used under such conditions but these operate at lowered efficiency. It also is impossible to design an electric motor that is absolutely dust and moisture proof. With an hydraulic application the hydraulic motor is inherently dust and moisture proof since any leakage that may occur is from the inside of the unit. First cost of an hydraulic drive is somewhat higher than direct motor drive, but where constant speed is required the net cost will compare favorably. When the matter of speed variation is introduced it usually is certain that the hydraulic system will be less expensive for drives of 25 horsepower or less.

Increases Diesel Throttle Range

Ordinarily when the term oil engine is used the designer feels somewhat restricted because few types of oil engines are available having throttle ranges comparable with the conventional gasoline engine. The matter of developing a transmission mechanically to overcome this handicap has been an economic problem, inasmuch as the number of gear changes soon becomes prohibitive. With an hydraulic transmission

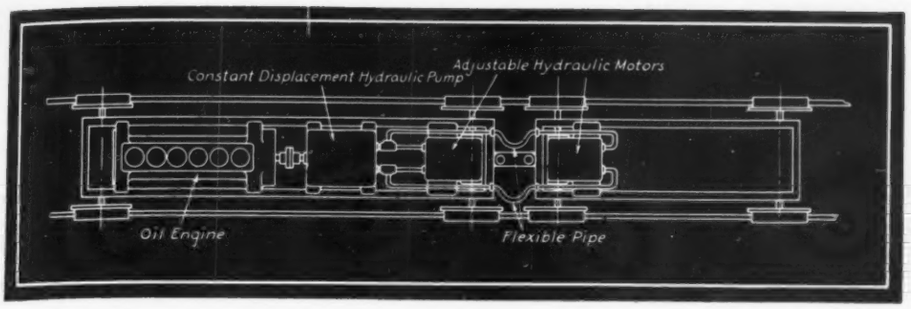


Fig. 5—Multiple system of operation for diesel drives includes two motors which compensate one another

the prime mover always can be operated at such speeds as effects maximum economy, resulting in lowered fuel consumption, freedom from excessive carbonization, etc., the speed range being secured through the hydraulic units. With the motor adjustable, high starting torques are available with little, if any, overload on the prime mover. Mechanisms can be developed so that the output of the engine can be regulated closely with the resistance of the hydraulic system which contributes to constant speed of the engine.

At the present time attention is being given to the possibilities of diesel electric drives. Much has been accomplished along these lines, particularly when using the Ward-Leonard system of control. Properly designed hydraulic systems would accomplish equivalent results in operation characteristics. The overall efficiency would be about the same as the electric drive but it would have the advantage of being capable of much higher momentary overloads.

Multiple Operation Possible

The multiple system of operation could be developed satisfactorily for the hydraulic drive, and on traction work either regenerative or dynamic braking could be designed into the system. Braking by means of friction would be eliminated in the ideal hydraulic drive since braking is an inherent characteristic of all hydraulic drives. These are interesting possibilities that theoretically as well as practically are sound in traction hydraulics, particularly as applied to bus and truck units. Practically all development along these lines has been an attempt to "put the cart before the horse."

Fig. 5 illustrates the idea of multiple operation. With this arrangement the two hydraulic motors are compensating, each taking one-half the total load. It is obvious, however, that the top speed of the combined units will be one-half that of a single unit when the displacement of the pump remains constant. This characteristic is not objectionable, for with a single unit only one-half the pay load is possible, and higher speeds are desirable as well as permissible. This system can be elaborated to combine several units but only with a proportionate reduction of speed.

Frequently it is necessary to perform several functions on one machine hydraulically, driven by motors, oscillating motors or cylinders. If the motors do not overlap in regard to the time element, one pump can be used to supply the necessary fluid. Since the pressure in any system depends upon the resistance, it follows that the unit requiring the lowest pressure will move first. By designing the various units to operate at pressures varying in intensity and sequence with the sequence of operation the various functions will operate in their proper order and no trouble will be experienced. Should two or more functions overlap, it is necessary to add a separate pump for each condition where overlapping occurs. It usually is expedient to design two or more chambers into the pump, thus eliminating a multiplicity of pump drives.

In designing step operation as outlined above, great care must be taken that the various resistances do not vary over an appreciable range because the failure of any one function due to resistance change would throw the system out of step for that cycle.

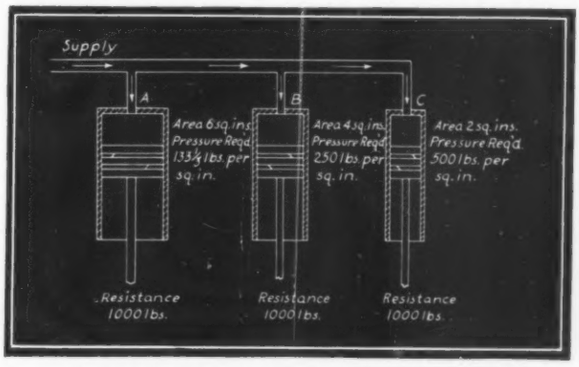

Supply
A
B
C
Area 6 sq. ins. Pressure Req'd. 133⅓ lbs. per sq. in.
Area 4 sq. ins. Pressure Req'd. 250 lbs. per sq. in.
Area 2 sq. ins. Pressure Req'd. 500 lbs. per sq. in.
Resistance 1000 lbs.
Resistance 1000 lbs.
Resistance 1000 lbs.

Fig. 6—Arrangement for sequence operation

Another method by which sequence operation can be secured is one in which the completed function of the first unit actuates the valve controlling the second operation; likewise, the second function actuates the valve for the third, etc. This permits the use of constant pressure units, assuming, of course, that they are designed so that the resistances in each instance balance at nearly constant pressure. If, however, space limitation requires a reduction in the physical dimensions of any particular unit, the pressure can be raised for that function independent of the other units. This system cannot get out of step at any time or under any conditions. If it should happen that any func-

tion is incompleted the following function will not start. While this latter system is more satisfactory for many applications, its principal objection is the introduction of additional valves and mechanisms, which, in turn, increases its first cost.

The matter of the overlapping of functions as previously described applies equally to both systems and usually is overcome in the same manner, i.e., by the introduction of additional pumping units.

It should be borne in mind by the designer that the conditions requiring variable displacement are extremely few. Where adjustable displacement units are available they are preferable, due to the much lower first cost, simplicity of design and fewer parts. Any reasonable number of displacement steps can be secured, and these varied to suit the particular application. This applies to both pumps and motors, and by combining the two the number of steps can be increased to a point where the performance approaches full variable displacement. As an illustration of this arrangement two 7-speed units are considered. The pump is designed for seven stages of displacement, and the motor likewise has seven stages. The total number of steps will then be the product of the two or 49 steps, half of which will be constant torque and half constant horsepower, depending upon whether the pump or the motor is adjusted. It therefore follows that two units of 15 steps will produce 225 steps, etc. Units having two different numbers of steps of displacement can be combined, i.e., a 15-step pump and 7-step motor, resulting in 105 steps.

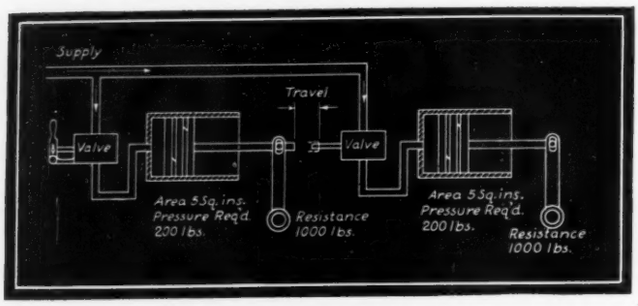


Fig. 7—Hydraulic controls for operating two cylinders in succession

In addition to steps with constant increments, irregular increments can be secured for special applications. Thus a pump can be designed to give a constant displacement for half the total volume of the pump and the other half divided into steps of equal increments. This combination would be suitable for a grinding wheel drive where a minimum wear diameter is allowable, such as 7-inch diameter for a 14-inch wheel. To illustrate this, a 14-inch diameter wheel operating at 6000 feet per minute surface speed would revolve about 1630. When worn down to 7-inch diameter it would require a speed of about 3260 revolutions per minute. The difference would be 1630 revolutions per minute. With seven speeds available between 1630 and 3260 it follows that an adjustment could be made for each inch of diameter between 7 and 14 inches. This would be good practice. Adjustments probably would not be made at more frequent intervals if full variable displacement were available.

Velocity Must Be Controlled

In designing ports for valves and other units it is good practice to hold the velocity of the fluid well under 12 feet per second, and units having drilled or circular ports require some figuring to determine the velocity. Fig. 8 is a velocity chart arranged to give a third value when any two are known. It is based on theoretical values and should help to avoid some of the drudgery of "cutting and trying."

Formula used for chart preparation, is,

$$\frac{\textit{U. S. gallons per minute} \times 231}{\textit{area of hole} \times 12 \times 60} = \textit{Velocity in feet per second}$$

For example, given,

25 gallons per min.
¾-inch diameter hole

To find the velocity

$$\frac{25 \times 231}{0.4418 \times 12 \times 60} = 18.15 \textit{ f.p.s.}$$

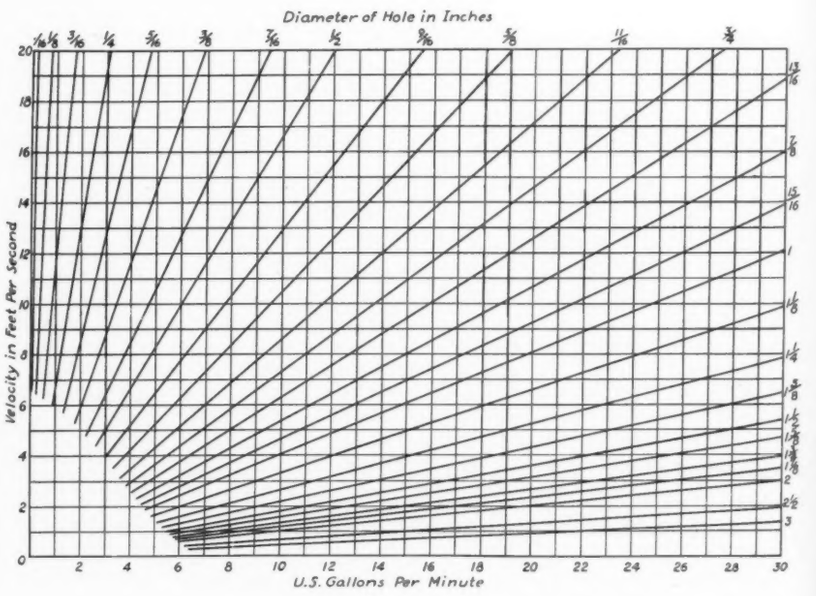


Fig. 8—Chart used for design of parts for valves and other units

Magnetic Control Permits Design Flexibility

By H. E. Hodgson

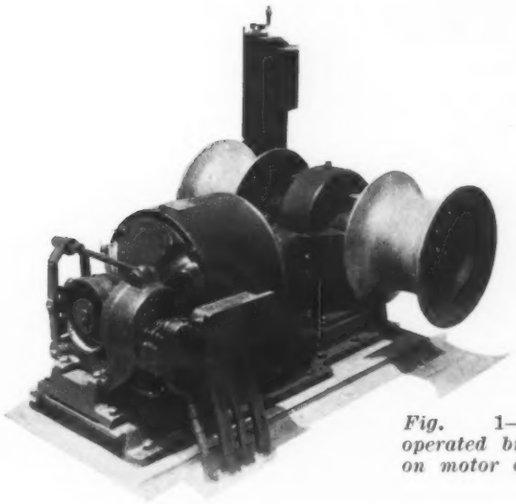


Fig. 1—Magnetically operated brake mounted on motor of boat crane

AUTOMATIC control of mechanical motions or control from a remote point are conditions suited admirably to the use of magnetic devices. Mr. Hodgson, mechanical engineer, Cutler - Hammer Inc., Milwaukee, presents the properties of these controls and shows how they may be applied.

WHEN it is necessary to move a machine element automatically through a fixed distance it is logical to consider the solenoid or electromagnetic means of accomplishing the action. Electromagnets provide for remote control and will amplify feeble actuating forces capable of establishing electrical circuits. Forces and travel of substantial amounts can be obtained from exceedingly weak actuating elements. New and unusual problems involving this type of equipment are continually presenting themselves, occasionally including one impossible of solution as was the case when a house wrecker wanted a magnetic roller which could be rolled along the side of a house to pull out the nails as it passed over them.

The electromagnet in its varying forms is a controllable means of translating electrical energy to straight line mechanical energy in limited amount, as shown by Fig. 2. It should be noted that the magnetization curve is representative of results obtainable with commercial steels. Refinements in magnet steels have been made and steels are available with which higher curves can be obtained but this advantage often cannot be capitalized and the cost of these steels is justified in only relatively few applications. Beyond a certain excitation no economic gain is made in the flux density and pull for increases in ampere turns in the coil. In different designs of magnets rather wide ranges of excitation are used, although the majority allow from 40 to 60 ampere turns per inch of magnetic circuit in the steel. Even with the maximum of density in the magnet there is a limiting pull per unit area of steel. The electromagnet designed for operation of mechanical devices usually provides the entire electromagnetic circuit and includes the well known solenoid form and the flat face magnet with its armature.

Electromagnets for alternating current circuits are built in entirely different structural form than for direct current. For alternating current circuits the flux in the magnetic circuit must make a complete reversal for each successive half cycle. Every precaution is required to provide a maximum of speed for flux changes. The steel circuit is made of thin insulated steel plates of special composition. The alternating current structure can be used for direct current circuits, but this refinement is not essential as the alternating current magnet rarely is used for direct current circuits. The proportions of copper and steel are different, so the magnet designed for alternating current, when wound for direct current, will produce only a small part of the force delivered with the alternating winding. In addition, the alternating current structure is not as strong mechanically as the more solid direct current structure. In design-

ing machines which may be connected at times into alternating circuits and in other cases be connected into direct current circuits, provision for the different sizes of solenoids should be made.

In applying magnets a designer must keep in

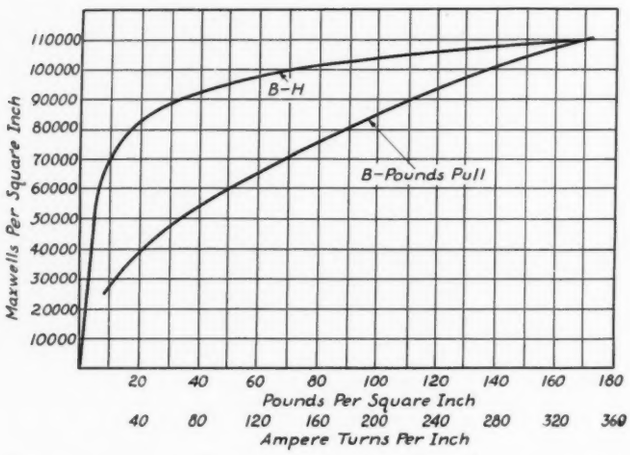


Fig. 2—Representative curves of magneto motive force, flux density and force for a commercial steel

mind the inherent timing of the magnet in addition to the capacity and physical dimensions. Probably no other one thing is forgotten as often as the fact that a certain amount of time is required in any magnet to complete its stroke.

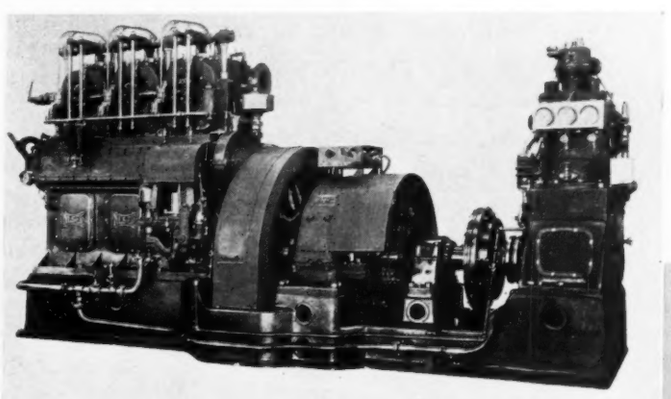


Fig. 3—Air compressor is driven by automatically controlled magnetic clutch to maintain air pressure as needed

The direct current magnet, particularly, requires time to build up the magnetic circuit to the point producing the required force. This is due to the inherent high inductance in the direct current structure, and increases with size.

In the alternating current magnet the timing is uniform for all sizes since the magnet must be designed with a minimum of inductance so that the magnetic flux may make a complete reversal each half cycle. The alternating current magnet is characterized further by a quite uniform pull value throughout the major part of its stroke. The time to complete the stroke is affected by the type of load to which the solenoid or magnet is attached. If the load is primarily a mass load (inertia load) the time is longer than when the magnet is working against a spring. The inertia load requires a certain amount of time for acceleration according to the relations between force, mass, distance, acceleration and velocity. When working against a spring load the only mass that has to be accelerated is that of the plunger of the solenoid or the armature of the magnet.

Frequency Introduces Timing Error

The error in timing in the alternating current magnet is affected by the frequency of the circuit. If the device is such that an inaccuracy of as much as a half cycle of time will affect the results, the alternating current magnet cannot be used. The actual time for the stroke of the alternating current magnet is short. One half cycle in the smaller magnets represents a large ratio of error in time of successive operations. For the direct current magnet the timing is effected principally by the voltage condition for successive operations. The total time of the stroke is considerably longer than for the alternating current magnet because of the higher induction of the magnet, but the total time for successive operations will be very consistent.

Uniform pull of the alternating current magnet throughout its stroke is accomplished by a continually increasing wattage as the stroke increases. The alternating current magnet is inherently a long stroke structure for maximum

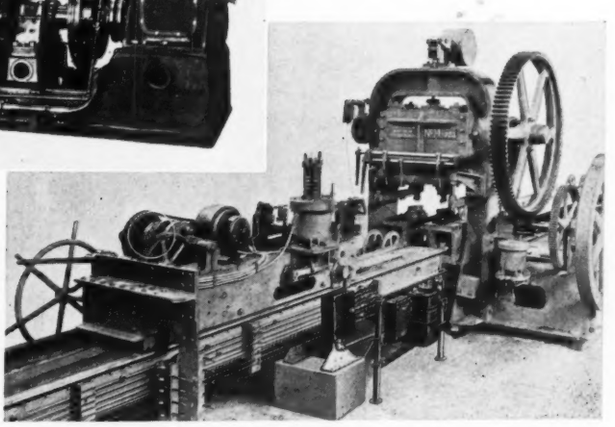


Fig. 4—Operations of driving a spacing machine carriage and locking it in registry locations are performed by a clutch of the magnetic type

economy in materials. The high current feature limits the size of magnet which it is feasible to connect in a given circuit. Current range between the maximum stroke and the sealed condition is as high as ten to one even in small magnets, and is in excess of that in the larger

magnets. Alternating current magnets are built commercially in energy ranges from one-half to 100 inch pounds.

Another limiting feature is that the velocity at the time of impact of the magnet faces must not be high enough to produce stresses beyond

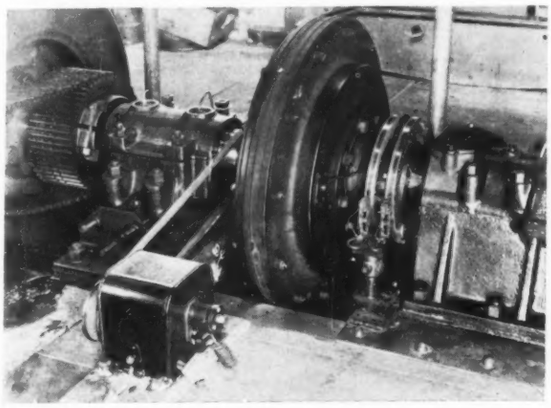


Fig. 5—Power is transmitted to a sand pump by a magnetic clutch which is cut out when a log, rock or other debris chokes the pump

the strength of the magnet material. The speed is somewhat hard to control unless the type and magnitude of load is known and the magnet is applied accurately. A common form of failure in the alternating current magnet appears as a brooming or separation of the laminations of the magnet plunger at the impact face. Successive impacts peen out the metal at the face and the restraining rivets are stretched or broken, allowing the laminations to spread apart. Characteristic magnetic pull and wattage curves for the two types are shown in Fig. 6.

In general, direct current magnets are inherently short stroke structures. This condition can be changed somewhat by providing two sections in the winding or by providing external resistance which is connected into the circuit as the magnet closes.

Designing Against Power Failure

Electromagnets should be applied in mechanical combinations so that power failure will not cause serious difficulty. This means that in brakes or other retarding devices operation of the electromagnet frees the rotating member. In clutches and power transmitting equipment the magnet generally is arranged so that it applies force and the driven member is freed when the magnet circuit is opened.

Alternating and direct current magnets are used in innumerable places and in an almost innumerable number of different mechanisms. Wherever it is desired to produce a certain mechanical result with the operator at a remote point it is almost certain that one or more electromagnets or solenoids are used.

The solenoid is used by a manufacturer of valves for steam lines in a power control valve. The valve is set slightly below the spring loaded safety valve and is used to increase the efficiency of the steam generating plant. This is accomplished since the range of pressure between opening and closing of the valve can be held to a low percentage of that required for the opening and closing of a spring loaded safety valve. The solenoid which operates this valve is actuated by a sensitive pressure regulating system which closes the circuit to the solenoid at the time the desired pressure limit is reached, and opens the circuit when pressure drops about 1 per cent.

A manufacturer of a spacing machine uses magnetic clutches and solenoids to regulate automatically the travel of the table which carries the piece being processed, Fig. 4, and in another solenoid application a cutting knife is operated as fast as 150 times per minute. Approximately 3.5 inch pounds of energy are used per cut from a solenoid with a rating of 7.5 inch pounds.

Electromagnetic brakes are used in hoists and trolleys of cranes of all sizes; on conveying systems; on door operating outfits; and in fact on

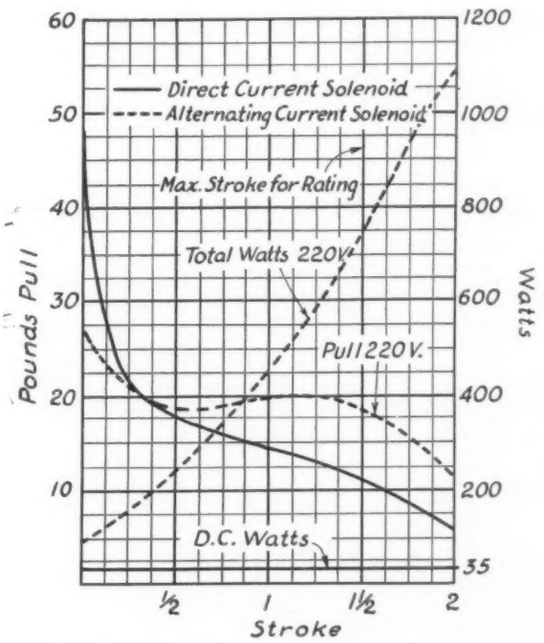


Fig. 6—Comparative pull and wattage curves for an alternating and a direct current solenoid of nearly equal weights

every mechanical power system where it is desired to stop quickly and stand in position. A majority of the magnets are for direct current. On shipboard, brakes are used on winches, cargo hoists, ammunition hoists, etc. Fig. 1 shows equipment with the brake on the left. The flat short stroke magnet can be seen clearly. The spring which holds the shoes against the wheel

passes through a hole in the center of the magnet.

Magnetically operated clutches are used: To accelerate a load at a predetermined rate; for auxiliary drives; for automatic and remote control; for high speeds; as safety cut-off couplings for quick stops; for measuring and indexing; for operation control in manufacturing processes; to save power; and in simplification of machines. Any type of prime mover may be coupled to its load by means of a magnetic clutch.

Fig. 3 shows an arrangement of engine, generator and compressor, which provides for driving the compressor only when pressure in the storage tanks drops to a low level. A pressure-sensitive switch may be used to maintain the pressure automatically within close limits.

A magnetic clutch to transmit power from a diesel engine to a dredge pump and provide a safety factor appears in Fig. 5. The small belt-driven control box in the foreground houses a centrifugal governor which opens the clutch circuit if the pump sucks up a tree stump or a boulder into the housing and jams, thus slowing down the pump and forcing the clutch to slip.

Automatic steering gear utilizes a clutch to regulate the rudder position. An arrangement of the motor, the clutch and transmission is shown in Fig. 7. A course is set and the instruments hold the boat in line through the mechanism illustrated. The clutch is mounted on a vertical shaft in this instance.

Exact Control Required

A recent installation of magnetic clutch and magnetic brakes was particularly exacting. In a continuous rolling mill system, as the bar approaches the shear it engages a flag switch. At that instant the circuit to the clutch and brake is closed and the shear is accelerated. Immediately after the cut has been made the circuit is opened to the clutch and the brake, the shear is disconnected from the driver and the brake stops it. An auxiliary drive carries the shear back to the registry position so that the next cut will be exactly the same in timing as the preceding one. The oscillogram, Fig. 8 shows the cycle of events for this installation. A remarkable feature of the installation is that the time for a complete cycle of operation is about 0.4 second and at maximum acceleration something in excess of 300 horsepower is being transmitted. Note the almost straight line acceleration.

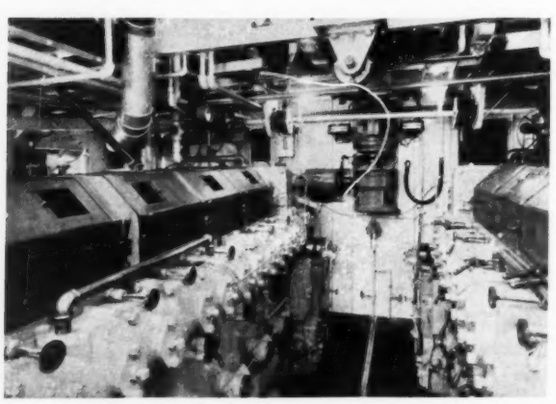


Fig. 7—Automatic ship steering gear utilizes a magnetic clutch for maintaining a constant course

The normal time interval in the cluch magnet various from 0.1 to 10 seconds in various sizes of clutches for building up the full magnetic force. In disengaging, the time interval is shorter but is still appreciable. One scheme for speeding up the operation of an electromagnet of the direct current type is used in the brake and clutch in the example cited in the foregoing and the results can be seen clearly in the oscillogram. The coil of the electromagnet is wound for less than line voltage and mains are provided to insert resistance in series with the coil after a desired movement of the magnet member has been accomplished. It will be noted in the two curves indicating brake current and clutch current that the magnet current reaches a peak value and drops off to a reduced value just before the circuit is opened entirely. Results approximating those with the alternating current magnet are obtained in this manner with direct current magnets. In order to get quick release of a direct current electromagnet it also is possible to provide a reverse connection to the line and sustain that connection only as long as required to dissipate the stored energy in the magnetic field. These extra features in the magnet control add to the complexity of the controller and to the amount of power required for operation.

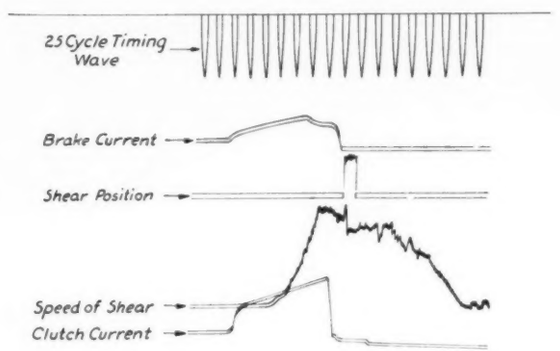


Fig. 8—Oscillogram which pictures the acceleration and deceleration in the metal shear

Solenoids and electromagnets have almost unlimited usage and may prove valuable in performing some job which cannot be done easily with other elements. Designers requiring devices to amplify feeble actuating forces or secure automatic response at a point remote from a control station should consider the electromagnet as a possible solution.

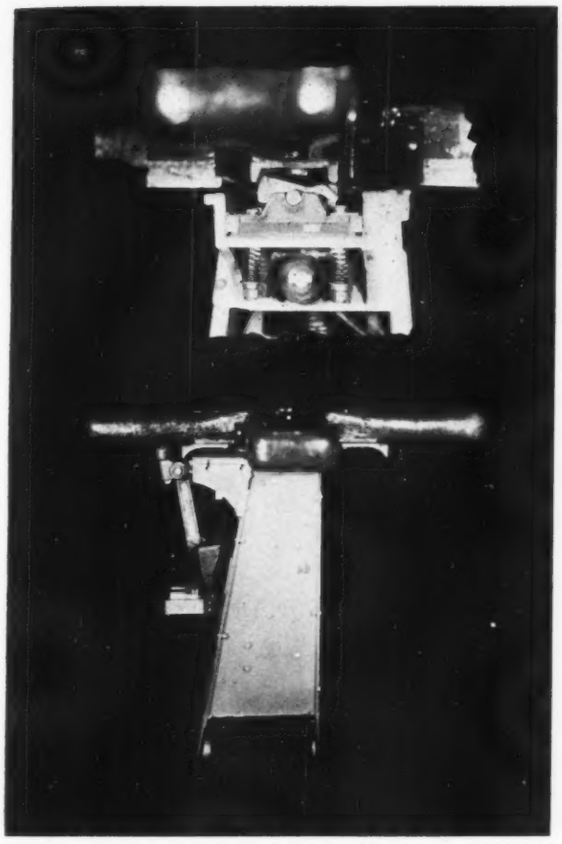


Fig. 1—Abrupt shock of stopping turnstile by metallic contact, top, was abandoned in favor of rotating a rubber roller against a cam, bottom

Solving the Noise Problem

By Allen F. Clark

Editorial Representative, Machine Design

MUCH of the noise present in machines can be eliminated by accurate fit of parts, proper balancing, gradual rather than sudden acceleration, and accurate machining, yet there are a number of disturbances that cannot be quieted by these methods. Also, since most designs are a compromise, even these ideals cannot be upheld at all times and vibration unavoidably will be encountered. Following the presentation of the general problem and the methods of measuring the noise developed, in the June, July and August issues, this article will present a few of the many examples where manufacturers have redesigned to reduce or eliminate noise.

One condition often encountered where production control will not solve the problem is where a moving part must be brought to an abrupt stop. Such an occurrence is especially undesirable in office machinery such as the "compotype" manufactured by Addressograph-Multigraph Co. In this machine a driving clutch operates twice in each revolution of a flywheel, causing annular cams on the shaft to revolve when an embossing key is depressed to bring the punches and dies in the die head together. In early models of the machine the mechanism was stopped by bringing a metal stop into the line of travel of the moving parts. This naturally caused a troublesome noise and jarred the machine.

The difficulty has been overcome in the latest models by cushioning the blow, thus eliminating most of the noise. In the new design, Fig. 2 *A*, a control lug, *a*, fixed to the clutch, is tapered on one side. The clutch is urged to rotate constantly by a spring. It is held stationary by the pressure of a lever against the tapered face of the lug, holding it between hardened plate *b* and lever *c*. When the sequence of operation requires rotation, the cam *d* turns counter clockwise, allowing the roller *e* on lever *c* to drop into the dwell, actuated by its spring, and the clutch makes one half revolution. The lever immediately is returned to its former position, and the clutch stopped by the action of the lug against the tapered face of lever *c*.

A similar difficulty was encountered in the design of subway turnstiles, by the Interborough Rapid Transit Co. In old designs, Fig. 1 (top), the turnstile was released by the lifting of a steel dog under the bar. After one quarter revolution, the arms came to an abrupt stop against this dog which had returned to its original position.

To overcome this shock, the principle of the pendulum was employed. A fulcrum bracket is bolted to the rear extension of the top casting of the turnstile, Fig. 1 (below) and from this the pendulum is suspended. At the top of the pendulum is a large rubber roller and under each arm a metal cam is

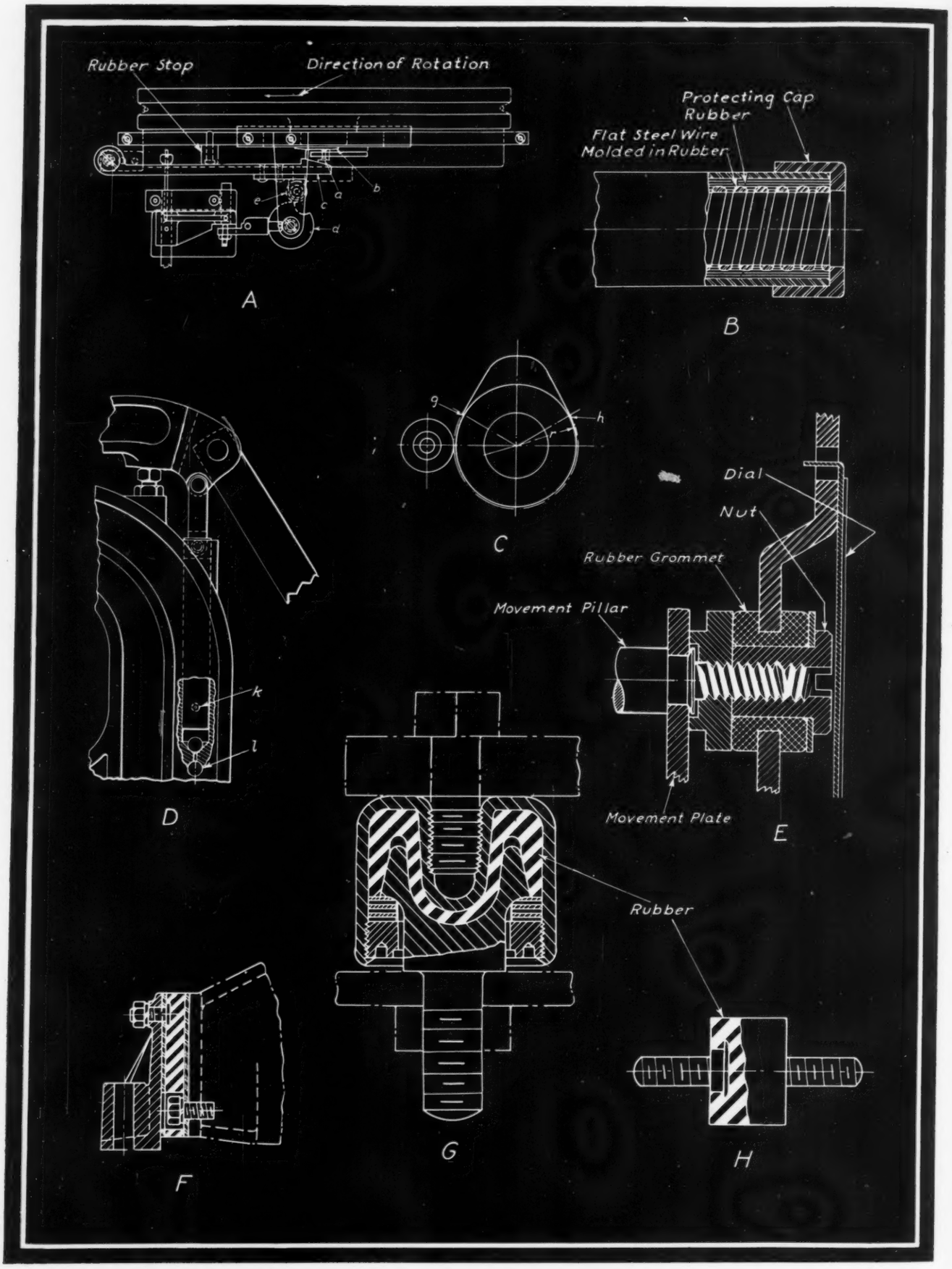


Fig. 2—Methods employed by manufacturers to eliminate noise in their machines includes cushioning stops, rubber encased parts, fastenings operating through rubber, flexible mountings and redesign of cams

attached. The lower end of the pendulum is held in place until the mechanism, put into operation by a coin, releases the stop and allows the pendulum to swing inwardly under the pressure of the cams turned by rotation of the turnstile. The cams are eccentric with the center of rotation. After the crossed arm is moved off center, the pendulum returns to the perpendicular position and is locked in place, thus allowing the roller to engage with the cam on the next cross arm and check the momentum of the cross.

In a pedal operated riveting machine, the shock is taken up and noise reduced by a pneumatic cylinder developed by Edwin B. Stimpson Co. This device, Fig. 2*D* draws air through valve *k* on the downward movement of the head, which corresponds to an upward movement of the piston. As the spring on the foot pedal returns the head to its original position, the piston compresses the air in the chamber. Some of this air escapes through port *l*, but at a certain point in the cycle the cylinder closes this port and the remainder of the air is held in the bottom, completely cushioning the blow.

Stock Rattling Quieted

Rattling of stock in the steady rests of automatic screw machines is another annoying source of noise. DeVilbiss Co. has solved this problem in the design of a device, Fig 2*B*, which consists of a length of rubber tubing inserted in an outer steel pipe and cemented in position. A coil of flat steel wire is molded in the rubber.

One of the most reliable methods of eliminating noise in gear trains or in geared connections is to provide composition gears to mesh with the metallic gears. This efficient method of providing quiet is too well known and has been too widely used and discussed to require further comment in this article. However, Continental Diamond Fibre Co. has developed a spoke type gear that still further reduces noise, Fig. 3.

In comparative tests of a solid web and a spoked gear for use on camshaft drives, in the solid web gear the volume of sound increased with the load while in the spoked type it decreased as the load increased. The volume of sound emitted by the spoked gear was only about one third as great as that from the solid gear.

Cams a Bad Noise Source

Cams are responsible for much noise in heavy machines. They pick up the mechanism with some shock which usually is dissipated as sound by the camshaft housings and by indiscriminate clatter of the cam operated mechanism itself. These mechanisms should be started from zero velocity which cannot be done unless the cam profile approaches the roller at a tangent normal to the line joining roller center and cam center. To accomplish this the roller clearance must be machined under the base circle, which may be done approximately as at *g*, Fig. 2*C*, or by a "transition radius" as at *h*. The first requires fine adjustment easily lost by heat and expansion of parts. The second accommodates itself to small changes of clearance with slight alteration of timing.

When other methods of eliminating noise are of no avail and vibration and consequent disturbance still are present, an effective means of quieting the machines is the employment of cushioning connections. Firestone Tire & Rubber Co. has developed one connection of this sort which has two bolt heads cured in rubber, Fig. 2*H*. This carries the load either in tension or compression, variable cushioning being obtained by varying the hardness of rubber. A similar

Fig. 3—Spoked type composition gear is much quieter than solid model made of same material

connection, Fig. 2*E* developed by Mechanical Rubber Co., has the rubber held between two metal mating members.

Flexible mountings make up by far the largest number of noise eliminating devices in use. Such a mounting is used in the design of the extremely quiet clock manufactured by Western Clock Co. The ticking noise that occurs at every oscillation of the pendulum or balance wheel in a clock of this type is inherent and inseparable from the design. It was, therefore, the object of the design to provide means whereby the sound of ticking not only was not amplified by the casing, but also to muffle the sound. In this clock the only connection between the movement and casing parts is through four grommets made of soft, live rubber, Fig. 2*E*. There is no metal to metal connection anywhere as it was found that even a slight touch of metal parts between casing and movement will transmit and amplify the ticking. Chrysler Corp. uses rubber in shear to cut down the vibration of its marine motor Fig. 2*E*. This rubber is cemented to metal plates which are bolted to the frame and to the motor.

With increased attention being devoted to noise elimination it behooves designers of all classes of machinery to study this problem in initial layouts. That is the time to take steps to obviate noisy mechanisms.

Editorial

Invaluable Weapon Is Found in Organized Research

ACCORDING to a study made by the division of engineering and industrial research of the National Research Council, manufacturers have been maintaining research activities at a high rate in spite of the depression in business. Of 350 companies reporting, half spent more for research in 1931 than in 1929; another fifth invested approximately as much in 1931 as in 1929.

This is indisputable evidence that research has entrenched itself as an indispensable tool of industry. Prior to the World war American manufacturers did not cling to research through periods of adversity as steadfastly as they have in the present depression. The answer must be that research is paying its way and that more and more industrial leaders recognize that fact. This assumption is supported by returns from companies in two large industries showing that 97 and 93 per cent, respectively, of the companies reporting today are actually marketing products created by their research departments within the past two years. Another significant point is that whereas a similar survey in 1928 revealed that no company reporting placed major emphasis on developing new products, the current study shows that 35 per cent of the companies consider new products as the principal function of their research activity.

Machinery manufacturers should note these two points, namely, that research may afford prompt returns and that the trend is toward greater emphasis on new products.

Patents Galore!

NO DEARTH of patents exists in the United States. Recent figures show that from the time records first were kept to the end of 1930 twice as many patents had been granted here than in any other country. France is in second position, with England and Germany following.

An almost infinitesimal number of the total patents granted by the U. S. Patent Office, however,—and undoubtedly this applies to other countries—are marketed successfully. In a statement printed elsewhere in this issue the claim is made that only 12 out of every 10,000 patents that are purchased prove profitable. Assuming the veracity of this assertion, huge sums of money are spent annually in obtaining patents which in most cases are worthless.

This condition to some extent must continue. No restriction can be placed on invention, and protection is essential. Yet a word of warning to overzealous companies and individual inventors, in view of the foregoing, seems in order.

Simon Stevinus

Master Designers

Simon Stevinus

DURING the period in the world's history when the Netherlands was one of the major powers and William of Orange was beginning to make his influence felt, there was born at Bruges, in 1548, Simon Stevinus, discoverer of many far reaching scientific facts. Known to his contemporaries by his military genius and inventions, Stevinus, often called Stevin, invented a defense by a system of sluices which was of tremendous importance to his country.

HOWEVER, the military achievements of this Dutch mathematician were not the innovation that have preserved his name in history. He was the first man to show that the pressure of liquids is independent of the shape of the containing vessel, a basic fact that has controlled hydraulic design. Skilled in mechanics and geometry, Stevinus proved another important theorem, the law of equilibrium on an inclined plane.

IN THE field of statics, he also distinquished stable from unstable equilibrium and demonstrated the resolution of forces. The importance of the theorem of the triangle of forces, enunciated by him in his *Statics and Hydraulics*, gave a new impetus to the study of statics which previously had been based on the theory of the lever. These scientific facts are of incalculable benefit to design.

ONE OF the developments for which Stevinus is known is the introduction of decimal fractions into common use by the publication of a small pamphlet in 1586. The pamphlet, soon translated into French, brought about the universal adoption of this method of computation. Stevinus illustrated his foresight by declaring the universal introduction of decimal coinage, measures and weights to be only a question of time, although they had been in little use previously. He, in company with other investigators, searched for a means of motive power that would displace animals. His contribution was the invention of carriage with sails which was used on the seashore and carried 26 passengers.

PROFESSIONAL VIEWPOINTS

Publication of letters does not necessarily imply that MACHINE DESIGN *supports the views expressed*

Comments and Questions from Our Readers. Machine Design Will Pay for Letters or Solutions to Problems Suitable for Publication

Determining Horsepower of Gears

To the Editor:

IN THE March issue of MACHINE DESIGN you published a nomographic chart which enabled the graphical determination of horsepower of spur gears. I believe it would be of interest if you would publish a diagram I have developed as a comparison as it is laid out in an altogether different way. All components of the equation are incorporated in one diagram, while the other solution needs two supplementary charts.

The velocity scale in this diagram, shown on page 42, is not needed for computing the horsepower. It was added as an additional asset for computing the safe load after the horsepower is found. Although the diagram lacks complete universal application (it is laid out for 14½-degree involute only) it incorporates on the other hand the speed factors *C*.

The diagram is laid out according to:

$$HP = \frac{SYAVC}{P33{,}000} \qquad V = 0.262\,DR$$

where

HP = Horsepower
S = Allowable working stress in pounds per square inch
A = Width of gear face in inches
Y = Form factor (14½ degree involute)
P = Diametral pitch
V = Pitch line velocity in feet per minute
D = Pitch diameter of gear in inches
R = Revolutions per minute
C = Speed factor

for ordinary metal gearing

$$C = \frac{600}{600 + V}$$

for carefully cut or ground gearing

$$C = \frac{1200}{1200 + V}$$

for laminated phenolic or rawhide gearing

$$C \frac{150}{200 + V} + 0.25$$

The example (dashed line) shows that for an ordinary cut steel gear of 2½ diameter, 20 teeth and 8 pitch, 1¼ face, 20,000 pounds per square inch, at 800 revolutions per minute, the transmitted horsepower is 7½.

Reading the velocity on the bottom scale as being 524 feet per minute, we will be able to compute the safe load from the formula:

$$Load = \frac{HP \times 33{,}000}{V} = 472 \text{ pounds}$$

—H. KAFFINE,
West Lawn, Pa.

A Benefit To Design

To the Editor:

IN THE timely editorial in the June issue under this heading, the plight of engineering graduates from our colleges and the near futility of their search for employment in their chosen profession, is, I am sure, in no sense exaggerated. As suggested, a small percentage of these embryo engineers will be able to return to college for postgraduate study and a comparative few will be absorbed into industry. But by far the major portion of these young men will be forced into idlness.

While our already over-burdened engineering societies undoubtedly will afford these men a cordial welcome to their technical and social facilities, even this avenue of approach necessarily must prove inadequate.

In view of the vast sums being expended on employment relief projects, I believe it is not without the bounds of reason to suggest that a modest appropriation be set aside to assist deserving students to continue postgraduate study where they could add to and keep a grip on the engineering knowledge already possessed in preparation for the time when theory could be put into practice.

I am sure such a scheme would have the wholehearted approval of every mature engineer and industrial leader, as well as the cooperation of and publicity in technical publications.

—ROBERT S. ALEXANDER,
Greenville, R. I.

Models, an Aid to Design

To the Editor:

TESTING machine design by means of models on which you commented in your editorial in the July issue, has many obscure advantages

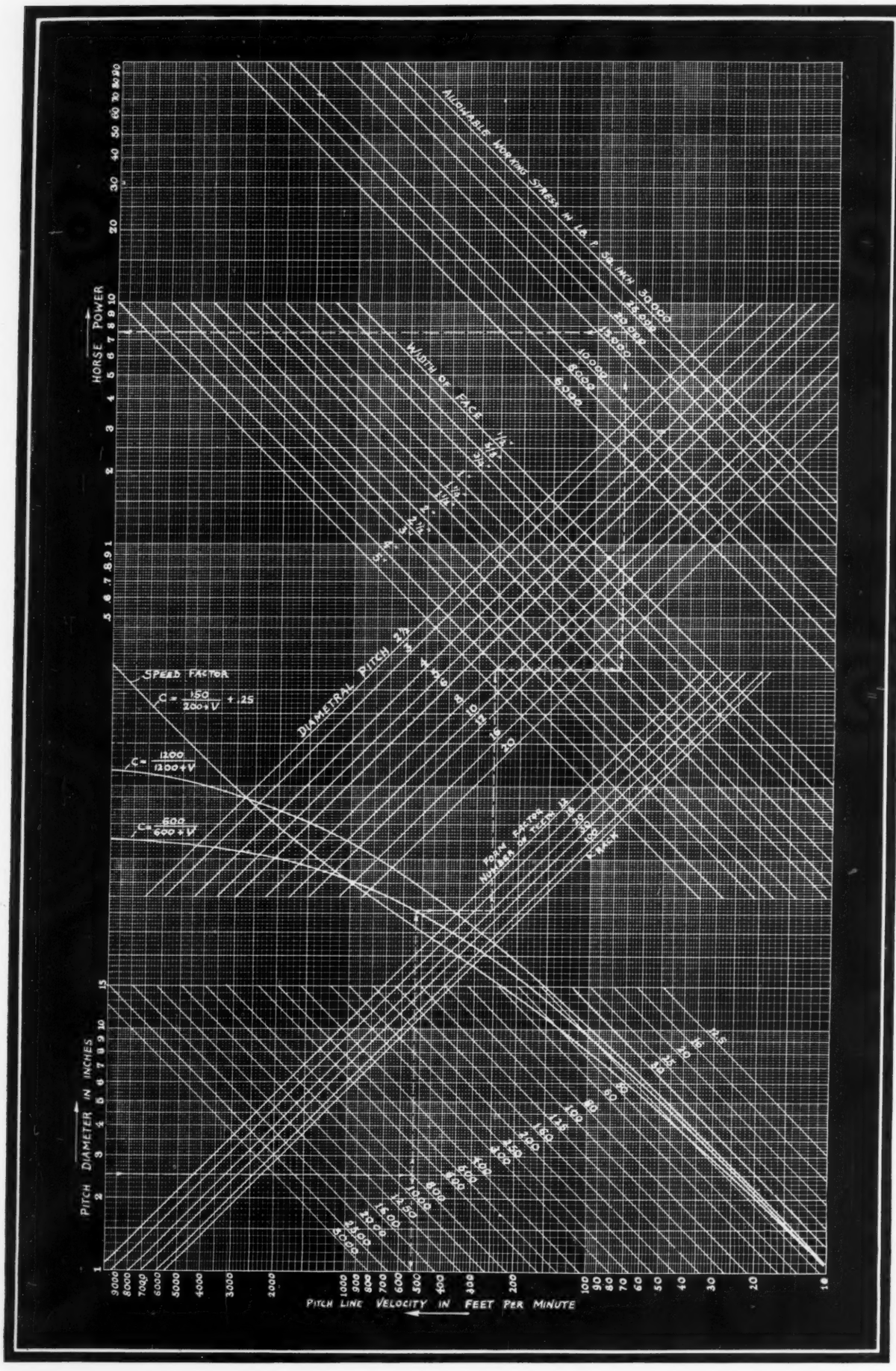


Chart for sp gear hor power simp fies steps design. For lae used its preparati are develop on page 4

which often are overlooked. Frequently the designer is called upon to prepare a complete layout of an untried machine which in the ultimate requires many expensive drawing changes before the perfected mechanism can be launched.

A more logical procedure for those in charge of design is to pick out the questionable, untried features and to have full sized or scale models constructed from temporary materials in order that these unknown variables can be studied and perfected. Needless pattern and machine work as well as drawing changes thus can be eliminated.

Model work has other advantages, one of the most valuable being its ability to "sell" ideas to those higher up who have control of appropriations for new equipment. If a working model, no matter how crudely constructed, can be demonstrated successfully before these executives, it usually is the final lever needed to convince even the most skeptical.

—H. R. POLLEYS,
New Haven, Conn.

A Benefit to Design

To the Editor:

I HEARTILY agree with the editorial under this title in the June issue and disagree with Mr. Forbes' comment published in August. The recent graduate engineer should go back to college if possible. It will be some time before he can secure a position because manufacturers want to hire back their old men first. They want to reorganize their old organization rather than organize a new one.

Mr. Forbes states that if a college man has enough money and brains to go back to school to get an advanced degree, he should be able to get a good job by buying it with his money. His words were not that but that was the inference. I disagree with him. It would cost less than four thousand dollars to go back to school for three years. If this four thousand dollars were invested in even a small business it would be only a drop in the bucket. A manufacturer would not hire any man because he would invest four thousand dollars unless he could bring some good ideas with him, because a business can last just so long on a set sum of money but will flourish as long as new ideas are fed to it. The average college graduate has not learned to think up new ideas and therefore could not get a job unless he invested much more money. Even then he would be only a figurehead until he got experience.

It is hard to realize the kind of men that are out of work today, but it is a fact that there are ten thousand dollar men wishing they could earn thirty-five dollars a week. What chance has the recent June graduate?

—R. A. PERRETT,
Oak Park, Ill.

Balancing Slender Shafting and Employing Couplings

(*Concluded from Page* 24)

movement. With two bearings clamped and the shaft running at fairly high speed, the amplitude of vibration at the third bearing was measured with a machinist's indicator; and counterweights applied by systematic trial until the vibration was reduced to a minimum.

In many cases an elastic coupling is not required to reduce vibration, but is necessary to allow for angular misalignment due to weaving of the structure; probably the lightest coupling for this purpose is the internal-external gear type. It sometimes is objected that this type is noisy, for its flexibility is due entirely to loose fitting; but as the teeth cannot separate under load unless vibration is so severe as to cause torque reversal the noise of the coupling might be regarded as a useful danger signal.

Among the elastic couplings there are several types available. In one form, Fig. 2 *A*, the drive is through compression springs preloaded in such a manner that no torsional deflection occurs until the torque reaches a certain predetermined value, the theory being that when vibration approaches a dangerous value the springs come into play and change the elasticity of the system entirely, thus destroying resonance. It can happen, however, that at certain other speeds a sudden accidental disturbance will bring the coupling into play momentarily and throw the system into resonance. Once deflected, there is no appreciable change of stiffness with amplitude so that resonant vibration once established can become dangerous.

Amplitude Is Limited

The coupling in Fig. 2 *B*, depends on the deflection of flat spring elements. It has a considerable amount of free play or backlash, but its stiffness increases with increasing deflection. It may respond to a large range of frequencies, but the amplitude at any given frequency definitely is limited.

The spring coupling in Fig. 2 *C* resembles this in principle and in elastic characteristics, but interleaf spring friction gives it a considerable damping action; the hysteresis amounting to about ten to fifteen per cent of each torque cycle. Consequently, although it responds to a wide frequency range, it possesses a powerful damping action.

An ingenious coupling is shown in Fig 2, *D*. It is of the familiar type that employs pins connected by links. The links are elliptical loops of flexible steel cable entirely imbedded in rubber. Under tension, the loops tend to straighten out, putting the rubber in compression.

MEN OF MACHINES

Personal Glimpses of Engineers, Designers, and Others Whose Activities Influence Design

RUBBER tires on all vehicular devices, dreamed Paul W. Litchfield, president of Goodyear Tire & Rubber Co. Inc., Akron, O., when he entered his early industrial career. That goal reached, he visualized the world's largest dirigible and in the completion of the navy airship AKRON last year, saw another ambition attained. For this contribution he recently was awarded the Spirit of St. Louis medal by the aeronautical division of the American Society of Mechanical Engineers.

Paul Litchfield thinks in terms of transportation. As a boy he watched the sailing ships from the Boston harbor, the place of his birth on July 26, 1875. Four years after finishing his engineering course at Massachusetts Institute of Technology in 1896, he joined Goodyear as superintendent of the factory. In 1906 he became a director, and president in 1926. He holds the same office also with Goodyear Zeppelin Corp.

Under Mr. Litchfield's direction Goodyear has been one of the leaders in the application of scientific principles and research in industry. His first step was to discard the old secret formulas and rule-of-thumb methods . . . engineering training was asserting itself. It was through his efforts in 1924 that his company acquired the German Zeppelin patents for the building of rigid airships in North America.

CLOSER liaison between technical societies and engineering schools is being effected. This is because faculty members of the latter are holding executive posts in society organizations in greater number. Just recently A. A. Potter, dean of the schools of engineering, Purdue university, became one of the outstanding figures in this group, having been nominated for the presidency of the American Society of Mechanical Engineers.

By birth a Russian, Dean Potter received his elementary education at Vilna in that country. When he came to the United States he entered Massachusetts Institute of Technology, graduating in 1903. In 1905 he started teaching engineering with the title of assistant professor of mechanical engineering at Kansas State college, advancing to full professorship in 1910. Three years later he was appointed dean and also director of its engineering experiment station and in 1925 received his doctor's degree in engineering from this college.

Purdue university won Dean Potter in 1920. Besides presiding over the engineering schools of that university, he heads the engineering experiment station and is professor of power engineering. He has been active in A. S. M. E. committee work and is a past president of the Society for the Promotion of Engineering Education.

AGRICULTURAL engineering has been the primary interest of Prof. Charles E. Seitz, newly elected president of the American Society of Agricultural Engineers. Exemplifying his devotion to this type of work is the fact that he organized and was made head of the department for agricultural engineers at Virginia Polytechnic Institute in 1918, continuing in this capacity to the present time.

As director of this division of the institute, Prof. Seitz supervises resident instruction, research and extension activities, including a special course in farm machinery. In recent years his department has given considerable attention to the design of various types of farm electrical equipment.

Born in 1891 in Reno, Nevada, Professor Seitz obtained his academic training at the University of Nevada, Ontario Agricultural college, and Iowa State college. He initiated the rural electrification program in Virginia and is author of several bulletins on agricultural engineering subjects as well as a contributor to the technical press and agricultural journals. By appointment of the secretary of agriculture he is a member of the national advisory council on research in mechanical farm equipment.

THERE are comparatively few individuals who successfully can combine mathematical and analytical skill with practical engineering judgment and inventive ability. Such a man, however, is Dr. Joseph Slepian, Westinghouse consulting engineer, who recently was awarded the John Scott medal, certificate and premium of $1000. Among the outstanding engineering innovations contributed by Dr. Slepian are a

Leaders in Design, Engineering and Research

P. W. LITCHFIELD

A. A. POTTER

CHARLES E. SEITZ

JOSEPH SLEPIAN

unique lightening arrester and a circuit breaker, the latter resulting from an observation made during study of the mercury rectifier tube.

Born in Boston, he attended the English high school preparatory to entering Harvard from which he was graduated in 1911, obtaining his Ph. D. in 1913. For graduate work he went abroad, studying at Gottingen, Germany, and at the Sorbonne, Paris. Returning to the United States he taught mathematics at Cornell and in 1917 became associated with the Westinghouse research laboratories.

He has written many valuable scientific and engineering papers and is well known as an international authority. He possesses the ability to take a complicated or difficult problem, analyze it into its fundamentals and explain the essentials in simple language.

* * *

George C. Kimball who has been made vice president of Illinois Steel Co. also is vice president of American Sheet & Tin Plate Co., Pittsburgh. He has been responsible for many important engineering developments in the flat rolled steel industry.

* * *

C. R. Paton has been appointed chief engineer of Packard Motor Car Corp., Detroit, succeeding A. Moorhouse who resigned to became an automotive consulting engineer. Mr. Paton has been in charge of the experimental engineering division for the past two years.

* * *

Perry L. Tenney has entered the service of Olds Motor Works, Lansing, Mich., in the capacity of engineer in the transmission division. He recently resigned as chief engineer of the Muncie Products division of General Motors Corp.

* * *

George G. Thorp recently was made president of Illinois Steel Co., succeeding Eugene J. Buffington. Upon completion of his course in mechanical engineering at the University of Wisconsin in 1891 he spent a year at the school in special research work.

* * *

William A. Hamor, Mellon Institute of Industrial Research, was recipient of the degree of doctor of science, awarded by Grove City college, Grove City, Pa.

* * *

C. W. Kinter, chief engineer of Follansbee Bros. Co., Follansbee, W. Va., for the past 20 years, resigned recently. A new unit for rolling tin plate just had been completed under his supervision.

* * *

Arthur Mallett recently joined the engineering staff of Federal Machine & Welder Co., Warren, O. He formerly was chief engineer of Thomson-Gibb Electric Welding Co., Bay City, Mich. Clyde Coates, formerly a design engineer with the Taylor-Winfield Corp., Warren, also has been identified with the engineering staff of the Federal company.

* * *

A. L. Bechtel, for a number of years vice president and chief engineer of Cleveland Punch & Shear Works, Cleveland, has established the A. L. Bechtel Machinery Co.

* * *

Earl W. Winans recently was appointed chief engineer of Federal Motor Truck Co., Detroit, to fill the position left vacant by the resignation of George B. Ingersoll, announced in the August issue of MACHINE DESIGN.

* * *

George A. Page Jr., until a short time ago design engineer with the Curtiss Aeroplane & Motor Co., Buffalo, has been appointed chief engineer of Curtiss-Wright Airplane Mfg. Co., Robertson, Mo.

* * *

Ernest von Mertens has accepted a position as engineer on development and production with the Groove Pin Corp., Long Island City, N. Y. He formerly was connected with the Scintilla Magnetic Corp., Sidney, N. Y., as engineer.

* * *

E. M. Underwood, for the past 14 years connected with the Fairbanks, Morse & Co., as sales engineer, has joined the combustion engineering department of Patterson Foundry & Machine Co., East Liverpool, O.

* * *

A. H. Gfrorer, chief engineer of the Automatic Transportation Co., Chicago, for the past 13 years and also chief engineer of Barrett Cravens Co., Chicago, for the last three years, has retired.

* * *

William B. Mayo, chief engineer of Ford Motor Co., and vice president in charge of aeronautical activities of the company, retired Sept. 1. He has been with the Ford organization for the past 20 years.

* * *

James D. Cunningham, president of Republic Flow Meters Co., Chicago, has been made a member of the board of trustees of Armour Institute of Technology, Chicago. For some time he has been chairman of the development committee of the institute.

* * *

Charles H. Marshall, until recently a member of the technical staff of Bell Telephone Laboratories Inc., has joined the staff of Lucius Pitkin

(*Concluded on Page* 66)

TOPICS OF THE MONTH

A Digest of Recent Happenings of Direct Interest to the Design Profession

BREWERIES, particularly since the probable return of legal beer is a live subject, are showing much interest in stainless steel as a metal for successful application in the form of fermentation vats, storage tanks, yeast pans, cooling coils, containers and various other parts of brewery machinery. Unlike some metals and materials, stainless steel has been found to have no effect on the flavor, and it does not impart any turbidity or haziness to the beer.

Another development of timely interest in this connection is that breweries in Switzerland have begun using stainless steel containers in place of wooden barrels for shipping beer. These containers, because of the strength of this metal, are much lighter than barrels. Moreover, in the past, bottled beer only could be pasteurized; this operation was not possible with wooden barrels because of the lack of heat transfer in wood. Swiss breweries by the use of stainless steel now are able to pasteurize all their beer. The market for new ferrous and nonferrous alloys appears to be a promising one, not only because of the inherent advantages of the metals but also because of the increased scarcity of wood suitable for barrels and other equipment.

* * *

Water Cuts Hardest Metal Alloys in Test

THERE is news in the announcement that a tiny jet of water can cut the hardest of steel alloys, but engineers are going a step further in learning just how this is done. The secret was revealed at Westinghouse research laboratories recently where the machine in which this takes place was developed.

The purpose was to determine the rate at which different metals wear away as they cut through the moisture-laden atmosphere at high speed. The machine reproduces in a few minutes the wear which would take place on airplane propellers spinning at high speed through rain and fog for months, or on steam turbine blades in years of service.

A disk wheel driven through gears by an electric motor has two plugs, specimens of the metal to be tested, which are screwed into the rim. These plugs travel 13½ miles a minute, cutting through two jets of water scarcely larger than a lead pencil at each revolution of the disk. Impact of the steel on the water fills the enclosing chamber with spray, and the moisture-laden atmosphere duplicates conditions of rain or steam-filled turbines in which steel blades rotate. Quarter-inch plugs of stainless iron and of nickel steel are eroded halfway through in two or three minutes.

* * *

U. S. Leads World in Patent Activity

SOME measure of discussion recently has centered about the fact that activity of American inventors exceeds that of inventors in foreign countries. The result of this activity is, of course, the issuance of more patents to Americans, and it is implied that the condition may account for the more frequent occurrence of changes which materially affect markets and distribution in this country.

Reports from the commissioner of patents at the end of 1930 listed 1,797,390 patents granted by the United States, as compared to 825,882 patents granted in France, 754,054 in England, and 531,681 patents in Germany. These figures are inclusive from the beginning of the first records kept in each of the countries and are the latest available for the foreign countries.

Since the beginning of the practice of granting patents to inventors 70 foreign nations have issued 4,395,493 patents to the end of 1930, as compared with 1,797,380 patents in the United States at the end of the same year. In this country 1931 was a record breaking year for the number of patents granted. Rapid economic development of the United States, leading industrialists declare, can be traced directly to the activity of inventors and the co-operation they receive from the patent office.

* * *

To Analyze Economic Problems in Survey

DESPITE the fact that a rising stock market may be indicative of better times ahead, the problems of production, consumption and distribution are no less a topic of discussion and study. A research program to analyze these factors and involving a half-million dollar budget over a three-year period now is being planned by the American Engineering council. Emphasis is laid in a recent report on the fact that the present crisis is not the result of an overdevelop-

ed technology, but is due entirely to unsuccessful technique in the distribution of wealth. The committee is composed of Ralph E. Flanders, L. P. Alford, F. J. Chesterman, Dexter S. Kimball and L. W. Wallace.

* * *

Anticipates Increased Use of Indium Metal

RICH ore deposits of indium have brought to light the possibilities of the metal in the automotive, electrical, jewelry manufacture and other fields. That interest has been aroused in the discovery is revealed in the report of Dr. W. S. Murray, Utica, N. Y., to the American Chemical society.

By careful and systematic search of all known ores, he says, a district has been found which flourishes in indium ore deposits. These have been made to yield a high percentage of indium content by concentration and will furnish substantial amounts of the element. Indium metal, first known in 1863, and named because of the indigo blue lines in its spectrum, has been removed from the ore electrolytically and by volatilization.

* * *

Chromium Plating Patents Held Valid

CONTROVERSY over chromium plating patents came to an end recently when the U. S. circuit court of appeals handed out the unanimous decision that Dr. Colin G. Fink, professor of Electro-chemistry at Columbia university, was sole owner. The result is that companies using the chromium plating process must be licensed by United Chromium Inc., holder of Dr. Fink's patents. Many plating plants already are operating under license but others are not.

Defendants in the suit contended that Dr. Fink had not been a pioneer in the development. The court, however, ruled that to discover why a process did not work commercially and to correct the trouble entitled Dr. Fink to the patent. It was not necessary that he should have been the first man to discover a method of chromium plating. The first process usable commercially was what he patented.

Behind Dr. Fink's success was the discovery that it was essential to use sulphate as a catalyst and keep it always in the proportion of 1 to 100 of chromic acid in the plating bath. Continuous plating, thereby, was made possible.

* * *

British Engineer Works on Noiseless Car

DEVELOPMENT of a 24-cylinder motor car without gear shifts and embodying an engine which will operate on the turbine principle is seen by engineers as one of the most forward steps toward the solution of the street noise problem. The inventor is Prof. A. M. Low, British engineer and noise expert, who for the past 44 active years has been working to reduce the number of distracting noises that exist in every large city.

It was Prof. Low's search for a noiseless motor car engine, upon which he embarked several years ago, that led him to seek to design an engine that would operate quietly. He already has to his credit a number of inventions for the elimination of noise.

* * *

To Promote Higher Professional Standards

THOSE who are wont to criticize the engineering profession for its backwardness in lifting its status to a higher plane will be interested in the announcement that an organization has been formed to promote higher professional standards of education and practice, to bring about greater solidarity of the profession, and to make the engineer more effective in dealing with technical, social and economic progress. The newly established body, the Engineers' Council for Professional Development, resulted from meetings over the past several months of representatives of seven professional engineering societies.

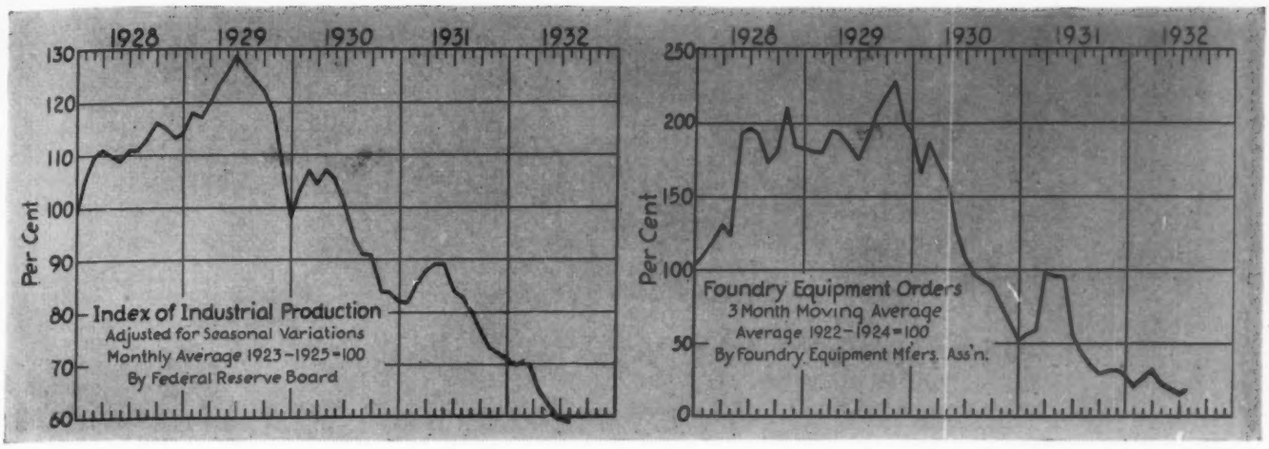
An immediate objective is to set up procedure and qualifications by which the progress of the engineer toward professional standing can be recognized by the public, the profession and the man himself. The plan comprehends a more or less automatic certification of the engineer in terms of at least minimum professional standards. Five of the seven engineering societies have ratified the new agency. They are the national societies of mechanical, electrical, civil and chemical engineers and the Society for the Promotion of Engineering Education. The American Institute of Mining and Metallurgical Engineers and the National Council of State Boards of Engineer Examiners, which have participated in the framing of the plan, are expected to take favorable action before October.

* * *

Soviet Engineer Completes Rail Zeppelin

FASTER transportation is one of the most talked about topics today and in this connection a recent Associated Press dispatch brings an interesting story from Russia. A Soviet engineer has designed a land zeppelin to operate on a special railroad between Moscow and Leningrad at a speed of more than 175 miles an hour.

The car resembles that recently tested in Germany but is said to be capable of greater speed. Design calls for motors fore and aft and a huge gyroscope to balance the car. It would complete the run between the two cities in less than two hours. Track and car together will cost about $2,000,000.

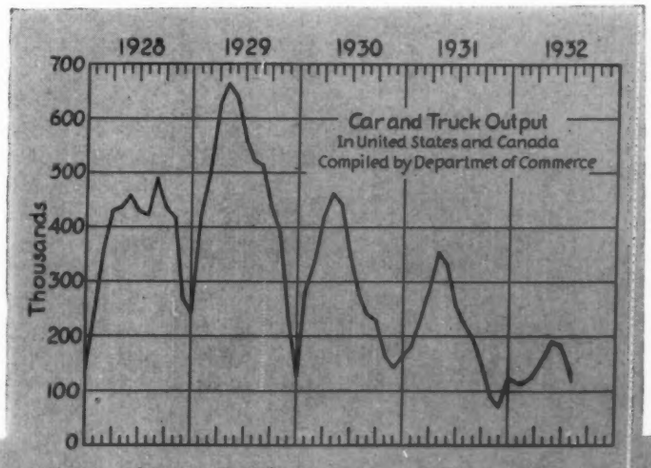


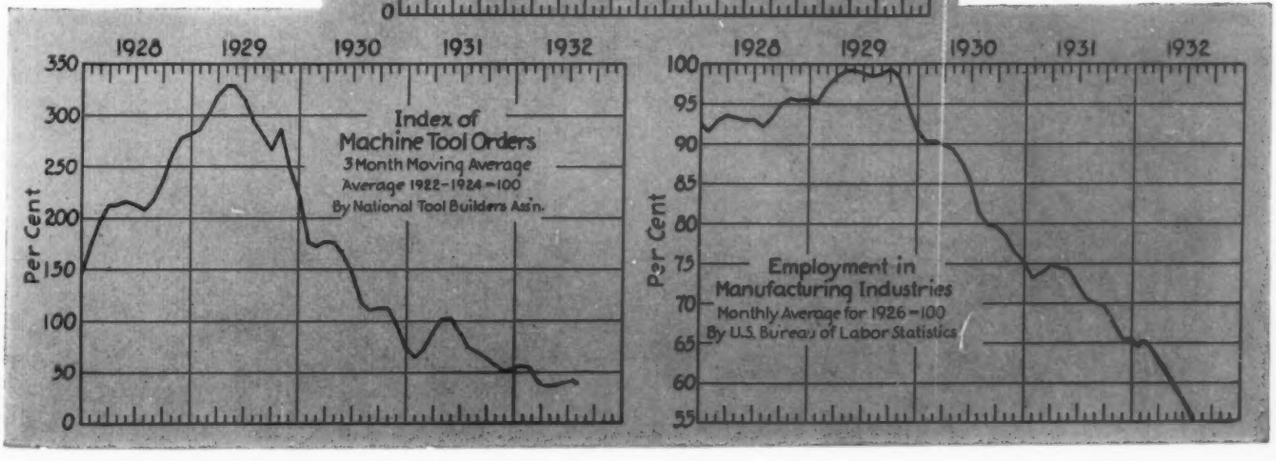
How Is Business?

SUSTAINED optimism is one of the most beneficial factors for business that can be developed, but this alone cannot assist development materially unless it is followed by definite, decisive action. Action, such as that which has been taking place in the last few weeks, not only will aid business in a concrete manner, but will increase the store of optimism and assist in the cycle.

The most outstanding step in this direction made recently is the decision of the United States Steel Corp. to spend $5,000,000 immediately on plant improvements and machinery. This is followed closely by the announcement that Remington-Rand Inc. will spend approximately $4,500,000 for material as this company believes that the present is the best possible time to replenish depleted stores. Four or five million dollars will buy a great deal of material these days, and put many men to work for at least several months.

These decisions seem to indicate that wise business heads believe it best to take advantage of present commodity prices before the commodity market rises still further. This market undoubtedly is being stimulated artificially to some extent by speculators, but increases in demand for cotton goods made recently necessitated that the mill owners enter the market to bargain for raw cotton. These purchases not only aided this commodity but all others and the purchases were of the type that is most beneficial; made to fulfill a definite need and not later offered for resale.





NOTEWORTHY PATENTS

A Monthly Digest of Recently Patented Machines, Parts and Materials Pertaining to Design

MOTION picture machines utilize a perforated strip feed mechanism to carry the film through the projector. Basically the arrangement consists of a series of sprockets, the teeth of which engage perforations along the two edges of the film, with proper guides and devices for retaining the film on the sprockets. In the newly patented invention of Albert S. Howell provision is made for conveniently and accurately determining the usual compensating loops of the perforated strip between the intermittent feed guide and the constant feeding means which carry the film strip to and from the guide. In the design he also has strived toward ease, speed and accuracy in lacing the strip on the feed mechanisms. By agreement Bell & Howell Co., Chicago, is named assignee of the patent which is designated No. 1,865,107. Details are shown in Figs. 1 and 2.

The body of the machine and the manner in which the film 12 passes from the top reel, through the head of the projector and on to the takeup reel, is shown in Fig. 1. Intermediate portions of the face guide members 7 and 8 are apertured as designated at 9, *B*, Fig. 2, in alignment with lens 6. This portion of the guide is straight so that the film at the aperture will be flat. Immediately above and below the straight section the guide is curved as shown at 11 in *A* Fig. 2, to strengthen the film at these points.

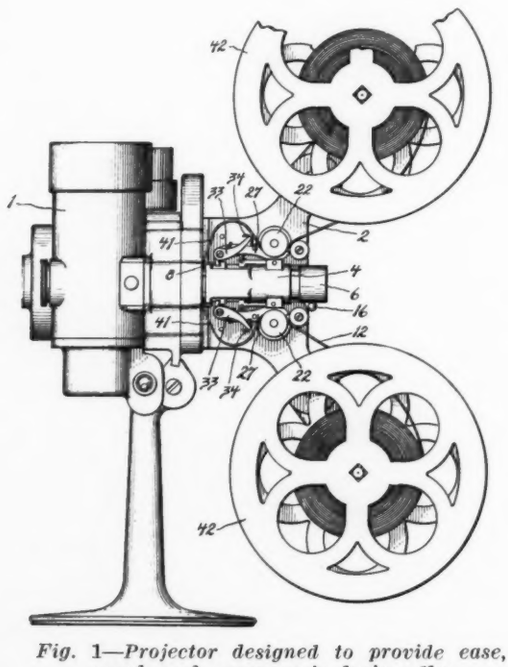


Fig. 1—Projector designed to provide ease, speed, and accuracy in lacing film

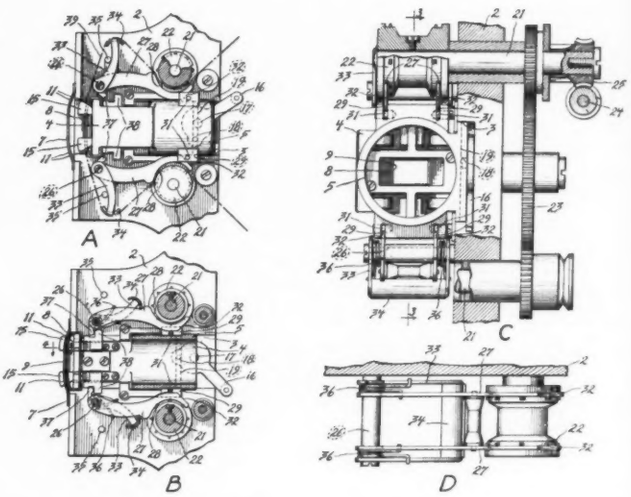


Fig. 2—Strip feed mechanism embodying sprockets, feed guide, film retaining arms and loop setters

Mounted on studs 26 is a pair of film retaining devices, each of which is inclusive of a pair of spaced retaining arms 27 which project forwardly from their studs between the lens mount member 4 and the adjacent sprocket 22, *D*, Fig. 2. Their forward ends are formed as shown at 28 to retain the film engaged by the teeth of the adjacent sprocket.

A pair of U-shaped loop-determining members 33, *A*, Fig. 2, are mounted pivotally by means of legs upon studs 26. These members are movable into and out of loop determining position, studs 35 on frame 2 limiting movement as shown at *A*, Fig. 2. In lacing or threading up the machine the film is trained about the various parts as depicted by the dotted lines at *A*. Following this the lever 16 is moved to its lower position, whereupon arms 27 and guide members 8 are moved to film-retaining position and members 33 are moved out of loop-determining position with the film engaged on the sprockets and in the feed guide, and with loops 41 of proper size, ready to place the machine in operation.

TO RELIEVE bearings of lateral strains due to centrifugal forces and to neutralize torsional vibrations arising when resonance exists between the shaft vibrating according to its nat-

ural period and the intermittent piston forces a balancing device for crankshaft has been designed by Roland V. Hutchinson. Patent No. 1,865,108 has been granted to cover the design and Packard Motor Car Co., Detroit, is assignee.

Construction is simplified by utilizing one of the counterweights to serve as the bracket to which the vibration neutralizer is pivoted. The center mass of the neutralizer coincides with the axis of the crankshaft, thereby avoiding the necessity of adding an opposing mass to balance it, and the pin about which the vibration neutralizer oscillates is relieved of load. Strains and friction on the pin are lessened by an arrangement of springs upon opposite sides of the pivot.

One embodiment of the invention, applied to a six-throw, four-bearing crankshaft of an automobile engine is illustrated in the accompanying drawings, Fig. 3. A side elevation is shown at *X; Y* is a transverse section showing springs 38 and 39 which retain the vibration neutralizer

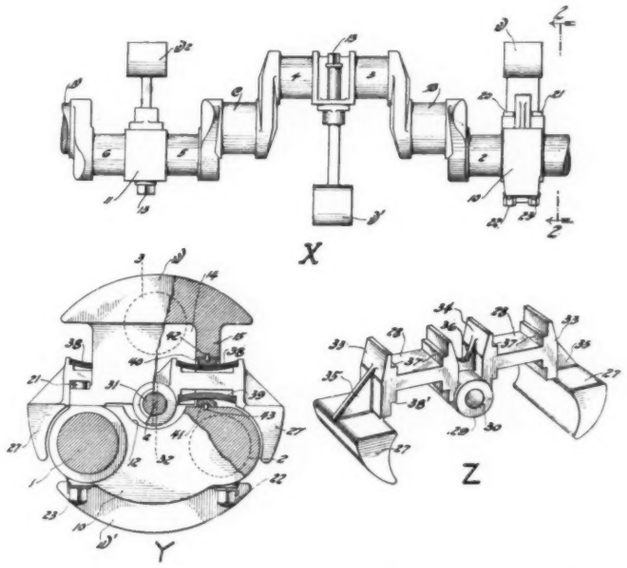


Fig. 3—Crankshaft balancer eliminates lateral strains on bearings and neutralizes torsional vibrations

26 in position; the detached vibration neutralizing member without springs is shown at *Z*.

To effect dynamic balancing of the shaft three counterweights, *W*, W^1 and W^2 are attached rigidly to it, being of such mass, angular displacement and radial distance from the center of the shaft as to maintain the shaft in static balance. The three counterweights are indicated in the drawings. In Fig. 3 *X*, *W* is shown as a specially constructed counterweight fastened to a crankarm.

Crankarm 10 which connects crankpins 1 and 2 is somewhat different from crankarm 11 which connects crankpins 5 and 6, crankarm 10 being bowed outward away from the axis of the crankshaft, indicated in the drawing *Y* by reference character *a*. The bowed form of the crankarm provides a concavity 12 which enables the vibration neutralizer to be pivoted about an axis coincident or in line with axis *a* of the crankshaft.

The vibration neutralizing body is indicated as a whole at *Z*, Fig. 3. At *Y* it is shown assembled with the crankshaft and counterweight *W* on crankarm 10 near the front end of the crankshaft. The neutralizer body is in the form of a bar with two overhanging end masses 27 connected by cross members 28 to a central pin receiving boss 29 having an orifice 30 to accommodate a bearing pin 31.

Steps or shoulders 37 serve as bearing abutments for the ends of two springs 38, each composed of leaves of spring steel. Springs 38 and 39, *Y* Fig. 3, have the same reactive force and are designed to be of such strength and elasticity as to retain the vibration neutalizer 26 in the position shown even if the pin 31 were not in place.

Mass member 26 is proportioned with respect to the total mass of the crankshaft assembly, and the strength and elasticity of the springs are so calculated, that when the crankshaft rotates at a critical speed at which resonance occurs the vibration neutralizer will be set into oscillations about the pin and against the springs, the resulting friction dissipating energy from the vibrating system at a rate sufficient to prevent resonant growth of the disturbance.

AN AUTOMATIC device which will inject minute quantities of liquid into a fluid pressure brake system adjacent an automatic valve has been designed by Charles A. Campbell. The invention for which patent No. 1,869,048 has been granted and of which New York Air Brake Co. is assignee, is intended primarily to inject a volatile liquid such as alcohol to lower the freezing point of water vapor and condensed water, thus minimizing the known tendency of triple and other valves to freeze to their seats.

In Fig. 4 is presented a plan and vertical section at *A* and *C*, respectively, while *B* shows the valve assembled with a combined quick service type of triple valve, auxiliary reservoir and brake cylinder. Extending downward into chamber 7, *C*, is a stem or hub 14 which carries at its lower end a disk 15. A coil spring 17 reacts against

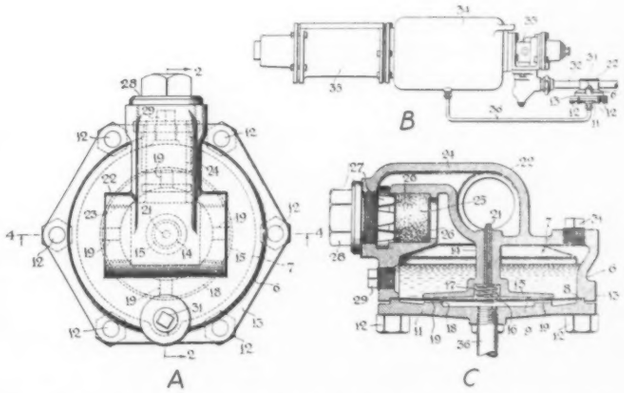


Fig. 4—Device for injecting minute quantities of liquid into fluid pressure brake system to aid valves

diaphragm 9 which is limited in its downward motion by annular stop 18. The parts are so proportioned that when the pressures on the diaphragm are equalized the spring 17 forces the diaphragm downward until it rests on the annular stop.

The device in use is interposed in the branch pipe 32, *B* Fig. 4, which leads from the brake

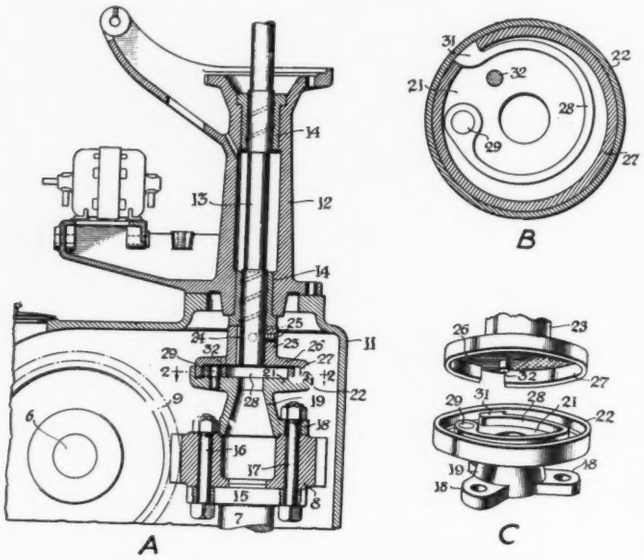


Fig. 5—Resilient coupling forestalls failure of drive if breakage of mechanism should occur

pipe or train pipe to a conventional triple valve 33. During charging of the reservoir 34 brake pipe pressure will predominate so that the diaphragm will be in the position shown at *C*, Fig. 4. Thus, if alcohol or other suitable liquid is in chamber 7 it will enter the space between diaphragm 9 and disk 15. This is the case under release and running conditions.

Variation in pressure flows in making a service application of the brakes is attended by a reduction of pressure in pipe 32. Since auxiliary reservoir pressure has not begun to drop and inasmuch as during the initial part of the service application it always is higher than brake pipe pressure, diaphragm 9 will be forced upward. It seals against the periphery of disk 15, trapping a small portion of alcohol or other liquid. Continued motion of the diaphragm upward forces this liquid toward the center and thence upward through nozzle 21, from which it sprays into the air current passing through fitting 22.

At the time the spray occurs the current is toward the triple valve, and it follows that the alcohol either in the form of a spray or a vapor enters the valve and comes in contact with its moving parts.

UTILITY of resilient couplings covers a wide range in design of machinery. One of the chief applications is in the driving of engine governors, to relieve the governor of the effect of minor cyclic speed changes, both accelerative and decelerative. In this class of service it is essential that failure of the resilient element of the yielding drive shall not destroy the drive of the governor, since stoppage of the governor while the engine is in operation probably would cause serious damage.

A coupling of this type has been designed by Clement Ruegg, to whom a patent No. 1,867,987, recently was granted. Nordberg Mfg. Co., Milwaukee, is assignee. Fig. 5 shows details of the unit. This is a diesel engine governor drive, *A* being a vertical section; *B* a section on the line 2-2 of *A;* and *C* a perspective view of the coupling members separated.

Hub 19 carries at its upper end a disk or circular plate 21 having a peripheral flange 22. The lower end of shaft 13 carries the other coupling element, which includes a hub 23, a disk plate 26 and peripheral flange 27. Flange 27 turns within flange 22 to enclose a space between disks 21 and 26 which houses spring 28.

The spring is connected by pin 29 with disk 21, the pin acting as a journal in the eye formed in one end of the spring. The other end of the spring is formed with a dovetail enlargement 31 which fits closely in a slot in flange 27. If the spring should fail, the part which encircles pin 29 would collide with the end adjacent 31. However, to provide for the remote contingency of failure by shear across dovetail 31, a stop pin 32 is fixed in disk 26.

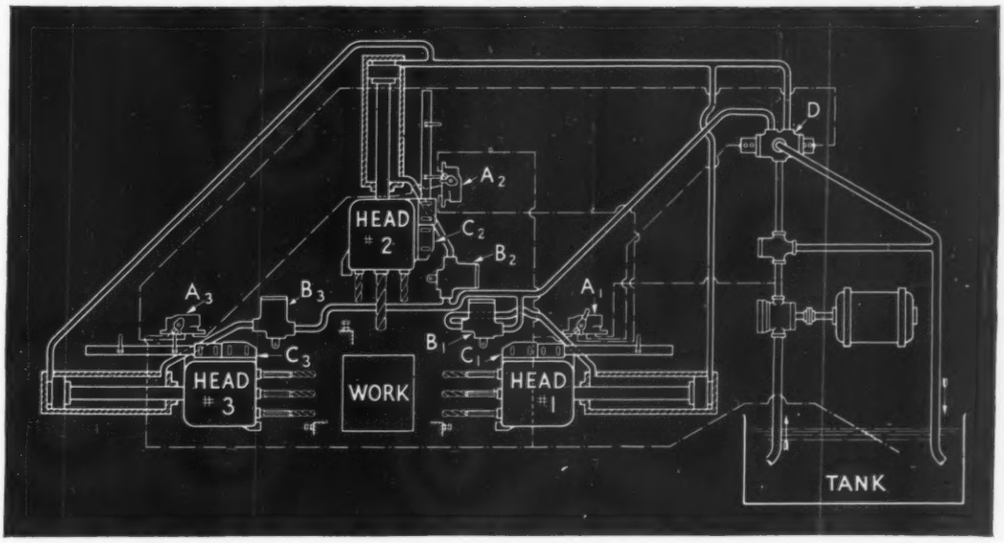
Research Publications

The Micro-Structure of Hardened Carbon Steel, by H. E. Publow and W. P. Fitz-Randolph. This bulletin is a thorough investigation of hardened carbon steel including a description of the steels, tests, charts of results and photomicrographs of the specimens. Published as bulletin No. 45 by Michigan State college, East Lansing, Mich. 19 pages. Free.

Note on International Comparison of X-Ray Standards, by Lauriston S. Taylor. More recently determined absorption coefficients have been applied to the measurements made at the National Physicial laboratory which raise their values by 0.7 per cent. Published as RP417 by bureau of standards. Available from Superintendent of Documents, Government Printing office, Washington. 1 page. 5 cents.

The Effect of Size of Specimen on the Strength and Elastic Properties of Cast Iron, by A. H. Dierker. The results of the tests reported show conclusively that, molding conditions being equal, the deformation per unit stress in ordinary cast iron varies according to the size of the section in which the iron is poured. The difficulty of judging this variation from the results of a single test specimen is apparent. Moreover, in the absence of more conclusive data than have been published the author questions the advisability of basing judgment on the results of tests of small specimens extracted from various parts of the casting. It would seem desirable in determining the physical properties of cast iron in sections of varying size to test, whenever possible, each section as a whole. Published as bulletin No. 72 by Ohio State university, Columbus, O. 16 pages. Twenty-five cents.

Multiple head machine operated by one pump; each head is individually controlled



REQUIRED

Rapid traverse the three heads simultaneously.

Feed two heads at drilling rate for a given distance and then at reaming rate for another distance. At same time, feed third head at drilling rate for a given distance.

Rapid return of all three heads to original positions after work of each has been completed.

Each cycle started manually by single lever.

All feed rates individually and easily adjustable.

CYCLE OF OPERATION

Operator starts the cycle by moving lever on valve A_1; this shifts valve D which starts all three heads forward at rapid traverse. The individual heads go into their proper feed rates when cams C_1, C_2 and C_3 contact valves B_1, B_2 and B_3 respectively. Steps on these cams change the feed rates at the required points. The rapid return of all three heads occurs when valves A_1, A_2 and A_3 have been tripped by stops attached to Heads 1, 2 and 3 respectively. No head can return until all three valves have been tripped. During the return, other stops trip valves A_2 and A_3 to their starting positions; valve A_1 is operated manually to begin the next cycle after the work has been changed.

The foregoing is an excellent example of the simplicity of Vickers Hydraulic Feeds. Their economy is evident from the following prices of all elements in the circuit:

1 Vickers V-Type Rotary Pump	$ 55.00
1 Vickers Relief Valve	25.00
1 Vickers 4-Way Valve	45.00
3 Vickers Variable Feed Control Valves	225.00
3 Vickers Pilot Valves	75.00
Total Cost	$425.00

Note that only one pump and one 4-way valve are required for the three head feeds.

Vickers Hydraulic Feeds reduce production costs

THE hydraulic feed on this 3-way drilling machine is typical of the standard Vickers Hydraulic Circuits that are now available for practically all kinds of machine tools. Each Vickers circuit is complete—all necessary controls are standard Vickers elements taken from stock.

Economical and efficient applications have also been made to many special machines because practically any required speeds and sequence of motions are obtained by using different arrangements of standard Vickers pumps, valves, etc.

Vickers Hydraulic Feeds require no complicated or delicate adjustments—no parts are under high stress and maintenance costs are much lower—"cushioning effect" of fluid avoids shock to work and machine—tool breakage is reduced—better finish is secured—production rate is higher—machine is protected against damage by overloading.

For further information, write to

VICKERS INCORPORATED
7752 Dubois Street, Detroit, Michigan

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MORE SIMPLE, EFFICIENT AND ECONOMICAL HYDRAULIC FEEDS AND CONTROLS

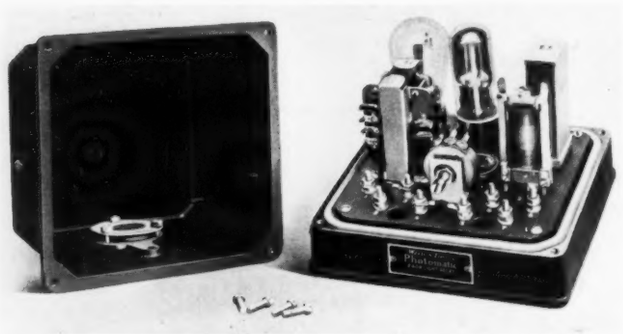
NEW MATERIALS AND PARTS

Worthy of Note by Those Engaged in the Design of Mechanisms or Machines

Photoelectric Unit Is Compact

A SIMPLE and compact photoelectric cell outfit which can be used in virtually any of the applications suitable for "electric eye" units is being produced by Western Electric Co., New York, under the name of Photomatic equipment. The system, designed by Bell Telephone laboratories, consists of two small units; one the light source and the other a light relay which contains the photoelectric cell. Both are designed to operate from commercial 50-60 cycle, 115 volt alternating current mains. The equipment may be arranged to open or to close an electrical circuit on either the interruption or completion of the light beam.

The photoelectric cell employed is of the caesium type widely used in sound picture reproducers but is in the vacuum rather than the gas-

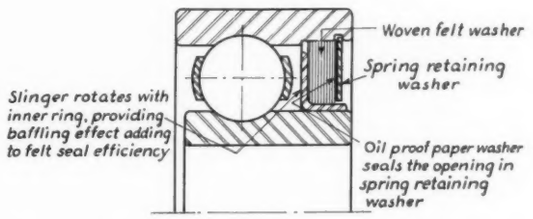


Photoelectric relay uses vacuum tubes of the caesium type widely used in sound picture reproduction

filled class. A vacuum cell is used because of its stability and its freedom from the possibility of injury by any illumination which can be given it by the light unit.

Seal Is Integral With Bearing

BY EXTENDING the width of both the inner and outer ring on one side of the ball race in the new "T" type seal bearing developed by Fafnir Bearing Co., New Britain, Conn., space is provided for fitting in of an entire seal assembly between the two rings. A steel slinger first is pressed on the inner ring, a woven felt washer placed next to it and held in position by a spring retaining washer fitted into a slight groove on the inside of the outer ring. An oilproof paper washer is slipped in between the felt and retaining washer in order to seal the opening in the latter.


Woven felt washer
Spring retaining washer
Slinger rotates with inner ring, providing baffling effect adding to felt seal efficiency
Oil proof paper washer seals the opening in spring retaining washer

Entire seal assembly is fitted between the two races in recently introduced bearing

The steel slinger rotates with the inner ring while the felt washer revolves with the outer ring, thus providing a baffling effect which adds to the seal efficiency. There is no interference with the hardened and ground surface of the outside diameter. The "T" seal construction presents outer ring faces which are finish ground and thus permit clamping of the outer ring in the housing. The same overall widths prevail as in the previous felt seal designs with the inner ring offset sufficiently to permit clearance when the bearing is mounted in a blind hole.

Redesigns Bearing Compensators

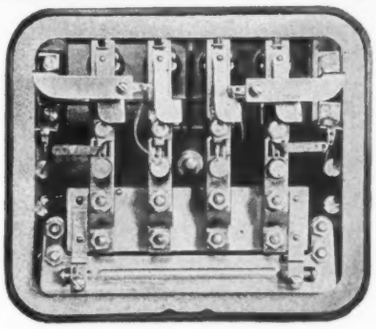
WYROMATICK compensators, designed to maintain constant bearing adjustments automatically, now are being marketed by Federal-Mogul Corp., Detroit, in a design which provides controlled preload. This insures that any clearance necessary to allow for expansion and contraction is controlled positively within the compensator, shown herewith.

Springs inserted in the master cam supply the power to take care of the preload feature and are varied in number to give the exact preload desired. The master and gage cams are a pair of mating helical cam faced members, which, when assembled in proper position, will increase

CORK HELPS KEEP THE 20th Century on time

The* GENERAL RAILWAY SIGNAL COMPANY *uses Armstrong's Cork to seal these relays against dust and dampness.

Glass case and Bakelite rim are cushion-sealed with cork.



(ABOVE) *The signal bridge on the New York Central at 125th St., New York City. Armstrong's Cork helps assure safety to the 20th Century and other crack limiteds over these tracks. The relays are housed between the legs of the signal bridge.*

(LEFT) *Bottom view of the General Railway Signal Company's Type K Neutral Relay. Note the Armstrong's Cork Gasket, with the two-notch Armstrong trade-mark.*

WINTER and summer . . . fall and spring, Armstrong's Cork Gaskets help keep these relay signal units operating efficiently. They cushion and seal the glass-to-Bakelite joint . . . guard against breakage due to expansion or contraction . . . prevent the entrance of injurious dust and moisture.

The General Railway Signal Company uses Armstrong's Cork Gaskets for this important duty because they stay compressible and resilient. They *keep on* cushioning—do not harden, shrink, or deteriorate with age. They are *lasting* seals against weather—give *lasting* protection against breakage. And they are simple to install because they always fit properly.

The cellular structure of cork accounts for its unusual properties . . . resilience, compressibility, resistance to liquid penetration, low thermal conductivity, chemical inertness, stability, and light weight. And these properties account for the wide and varied use of cork in industry.

★ ★ ★

Engineers, Designers

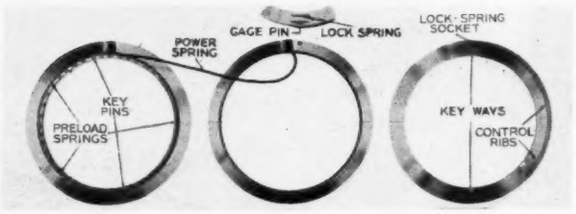
Perhaps Armstrong's Cork can help make *your* product more efficient. Feel free to consult our Industrial Sales engineers on any problems of sealing, cushioning, sound deadening, friction, or insulation. Outline your needs and, if possible, send us a blueprint. Armstrong Cork & Insulation Company, Industrial Sales Division, 918 Arch Street, Lancaster, Penna.

Armstrong's (A) *Product*

Armstrong's CORK

MADE TO YOUR SPECIFICATIONS

their joint cross sectional dimension when rotated in opposite directions. When the compensator is assembled, it is wound and held in the wound position by the lock spring which engages in the spring socket. When drawn up in a bearing assembly, the pressure releases the lock spring. Then the power spring urges rotation in the gage cam but this rotational action is stopped by the gage pin engaging one of the



Disassembled parts of redesigned compensator which adjusts for wear in bearing or in mating parts

ribs on the control washer. It cannot pass this point.

Assuming the compensator is set to take up wear in increments of one thousandth, the preload springs urge separation between the master cam and control washer and likewise the lock spring urges separation between the gage cam and control washer. When one thousandth of wear has occurred beyond that initially allowed as minimum for expansion and contraction, the gage pin passes one rib increasing the joint cross section exactly .001 inch. No further movement takes place until additional wear requires further expansion.

Motors Offered In New Ratings

NEW ratings have been added recently to the line of split phase motors manufactured by Century Electric Co., St. Louis. This line now

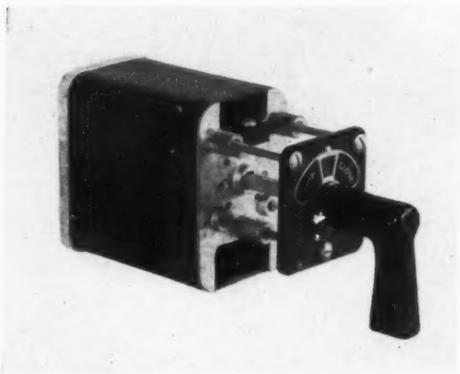
Split phase motors are protected against falling objects and dripping water

is built in ratings from 1/60 to 1/3 horsepower. The end brackets of the motors, shown herewith, are cast from close grained gray iron and are designed to protect the motors from falling objects, dust or dripping water. Frames are of rolled steel construction.

Bearings are machined from phosphor bronze castings and are thick walled. The wool yarn system of lubrication is used. One year's continuous 24 hours per day operation without reoiling is permissible.

Switches Have Interchangeable Parts

COMPACT switches for electric operation of circuit breakers, governors, rheostats, instrument transfer, etc., known as SB-1, have been brought out by General Electric Co., Schenectady, N. Y. The various combinations for different applications are made up by means of interchangeable parts. The combinations differ only in the number of contacts and the arrangement of cams for operating the contacts. All contacts are silver-to-silver.



Interchangeable parts permit construction of standard switches for special uses

The breaker control switch is available with auxiliary contacts to operate in connection with the dim-bright indicating lamp scheme. With this method, a red light indicates that the breaker is closed; a dim clear light indicates that it is open; and a bright clear light indicates that the breaker was tripped automatically by means other than the control switch.

Linestarters Are Explosion Resisting

EXPLOSION resisting linestarters in a new line have been announced by Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. The equipment, shown herewith, has been developed for use in Class I, Group D, hazardous locations. That is, they are designed for use in locations where highly flammable volatile liquids or gases are manufactured, used or handled. They are intended particularly for use around oil refineries, dye plants, chemical plants and similar locations.

The starters consist of a standard linestarter units mounted in heavy cast iron cabinets with

250 Horse Power Century Type SC Squirrel Cage Induction 3 Phase Motor

When the job requires rigidity—liberal mechanical strength—ability to withstand shocks or hard service, call for a Century Polyphase Motor . . . The results will be satisfying.

Cast Iron Frame . . . Cast Iron End Brackets . . . Ball or Phosphor Bronze Bearings.

250 Horse Power and Smaller, Single and Multispeed . . . Totally Enclosed Fan Cooled . . . Vertical . . . For all the applications and installations for which an induction motor is suited.

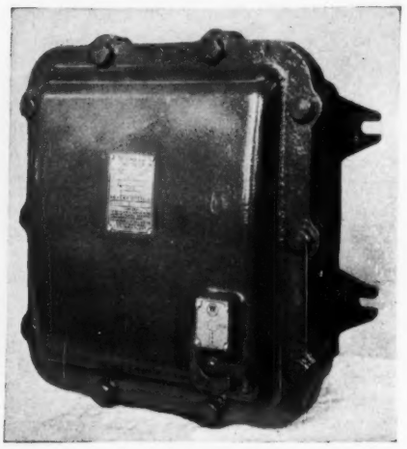
Century MOTORS

Century will give you Real Engineering Advice on the selection of the right motor for any job.

CENTURY ELECTRIC COMPANY
1806 Pine St. St. Louis, Mo.

OFFICES AND STOCK POINTS IN PRINCIPAL CITIES

wide flanges. De-ion contactors and combination hand and automatic reset thermal overload relays are incorporated. They are built with separately mounted push button or with built

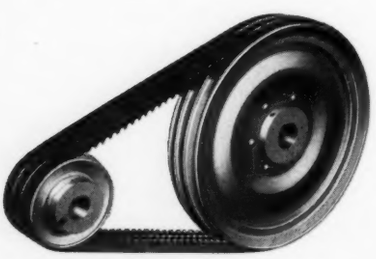


Linestarters are designed for use in locations where highly flammable liquids or gases are present

in push button. Explosion resisting push buttons for two wire control (low voltage release) and for three wire control (low voltage protection) are available.

Drive Pulleys Are of Lighter Weight

CONSIDERABLE saving in weight and increased economy are available with the application of a new line of "Day-Steel" single and multiple V-groove pulleys for ratings of 7½ horsepower and below recently introduced by Dayton Rubber Mfg. Co., Dayton, O. The pul-



Line of V-groove pulleys is balanced carefully to insure true running

leys are formed accurately from heavy gage pressed steel, welded both at the rim and at the web and assembled with a hub of unique construction to give an accurately balanced and true running pulley of exceptional ruggedness. They are finished with aluminum paint.

Reducers Are Unusually Compact

DUE to its compactness and flexibility, the new line of power reduction units being manufactured by Merkle-Korff Gear Co., 213 North Morgan street, Chicago, have a wide range of applications. Gear housing in the units, shown herewith, is neat and compact. Gears run in grease which is sealed in insuring positive lubrication and quiet operation.

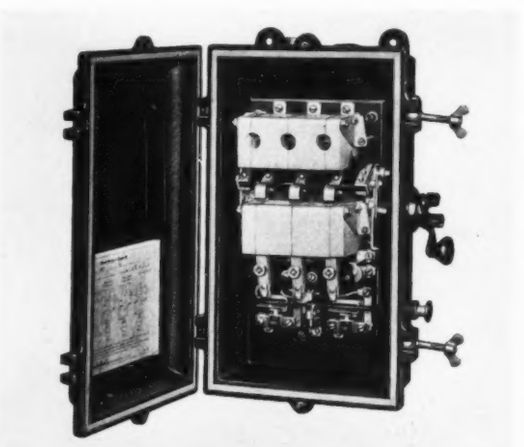
The unit is so constructed as to be attached easily to any device or mechanism. It can be supplied with both horizontal and right angle drives, while right angle drives can be had in any position within the 360 degree circle. An induction, shade pole type synchronous motor

Reduction unit can be attached to any device or mechanism to form integral part of design

is used. Practically any speed from a motor speed of 3000 revolutions per minute down can be satisfied, while the unit can be supplied for either clockwise or counterclockwise rotation.

Announces Water Tight Starters

ALTERNATING current combination starters of water and dust tight construction in the cast iron type have been added to the line of



Starters are dust and watertight

starters manufactured by Industrial Controller division, Square D Co., Milwaukee. The apparatus is intended for installation in damp or dusty

MINNIE THE MOOCHER

INDUSTRIAL VERSION

● The villainess in the industrial version of this song would be Faulty Lubrication. She not only mooches profits from your customers, but she mooches the reputation of your firm and of yourself as a designer.

The tragedy of industry is that this villainess goes unsuspected while good guys get the blame. But there is a way to foil her and thousands of designing engineers are now giving her the run around.

The answer is—specifically specify that only Special Alemite Lubricants be used on the machines you design. You can rely upon them always to do the particular job assigned. For there is a Special Alemite Lubricant for every special need in industry.

May we send you complete information on this important subject? It will save you many a headache and the equipment you design some 80% of the failures due to faulty lubrication.

ALEMITE CORPORATION, (Division of Stewart-Warner) 619
2644 N. Crawford Avenue, Chicago, Illinois

Gentlemen: I am interested in information regarding Alemite Systems and Lubricants from the designer's standpoint.

Name .....

Company .....

Address .....

City ..... State .....

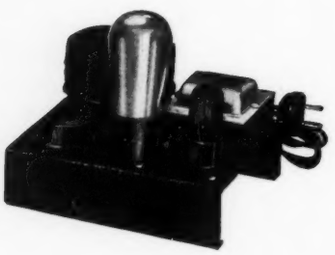
PIONEERS IN SPECIALIZED LUBRICATION FOR INDUSTRY

locations and corrosive atmospheres such as found in flour and starch mills, cement plants, foundries, packing plants and similar places. This equipment is not explosion proof.

The unit consists of an across-the-line starter, motor control switch and test jack. Thermal overload protection and low voltage protection are provided. Starters are built in two sizes known as Class 8532S and 8536S, and can be furnished fusible or nonfusible. The switch mechanism is enclosed in a cast iron cabinet having machined flanges and is fitted with rubber gaskets to exclude moisture and dust.

Switch and Relay Are Combined

PHOTOELECTRIC relays embodying an electromagnetic switch which is opened or closed by the interruption or variation in the illumination on a photoelectric cell are being marketed by G-M Laboratories Inc., 1735 Belmont avenue, Chicago. With the unit, shown herewith, any



Electromagnetic switch is embodied in photoelectric relay

type of electrical device such as motors, electric signs, signals or alarms, can be controlled through the medium of a light beam.

The unit is capable of handling many industrial applications including employment as a limit switch, regulating the flow of crushed stone, gravel and similar products, operation of safety devices, and similar uses.

New Wing Nuts Are Cold Forged

A COMPLETE line of cold forged wing nuts has been developed by Parker-Kalon Corp., 200 Varick street, New York. The wings of

Wing nuts have no sharp corners that might cause injury

the nuts are uniform and so shaped as to provide ample finger grip for drawing them tight and to facilitate removal. They have no sharp corners or rough edges that might cause injury. Holes are located centrally and accurately punched, insuring a clean cut uniform thread. The base of the nut is smooth and square with the top so that it will draw up tight and flush with the work.

Explosion Proof Controls Developed

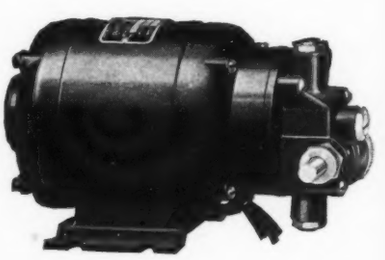
AIR break type, direct current, explosion proof manual controls approved and rated "permissible" by the bureau of mines have been

Thermal overload and low voltage protection included in controls

announced by Cutler-Hammer Inc., 328 North Twelfth street, Milwaukee. These two pole, across-the-line starters, shown herewith, have thermal overload and low voltage protection. They are rated 4 horsepower at 230 volts and 5 horsepower at 550 volts. A main line fuse is built directly into the case. The overload when tripped is reset by the outside operating lever. The case is of cast iron with a screwed on cover.

Announces Improved Small Motors

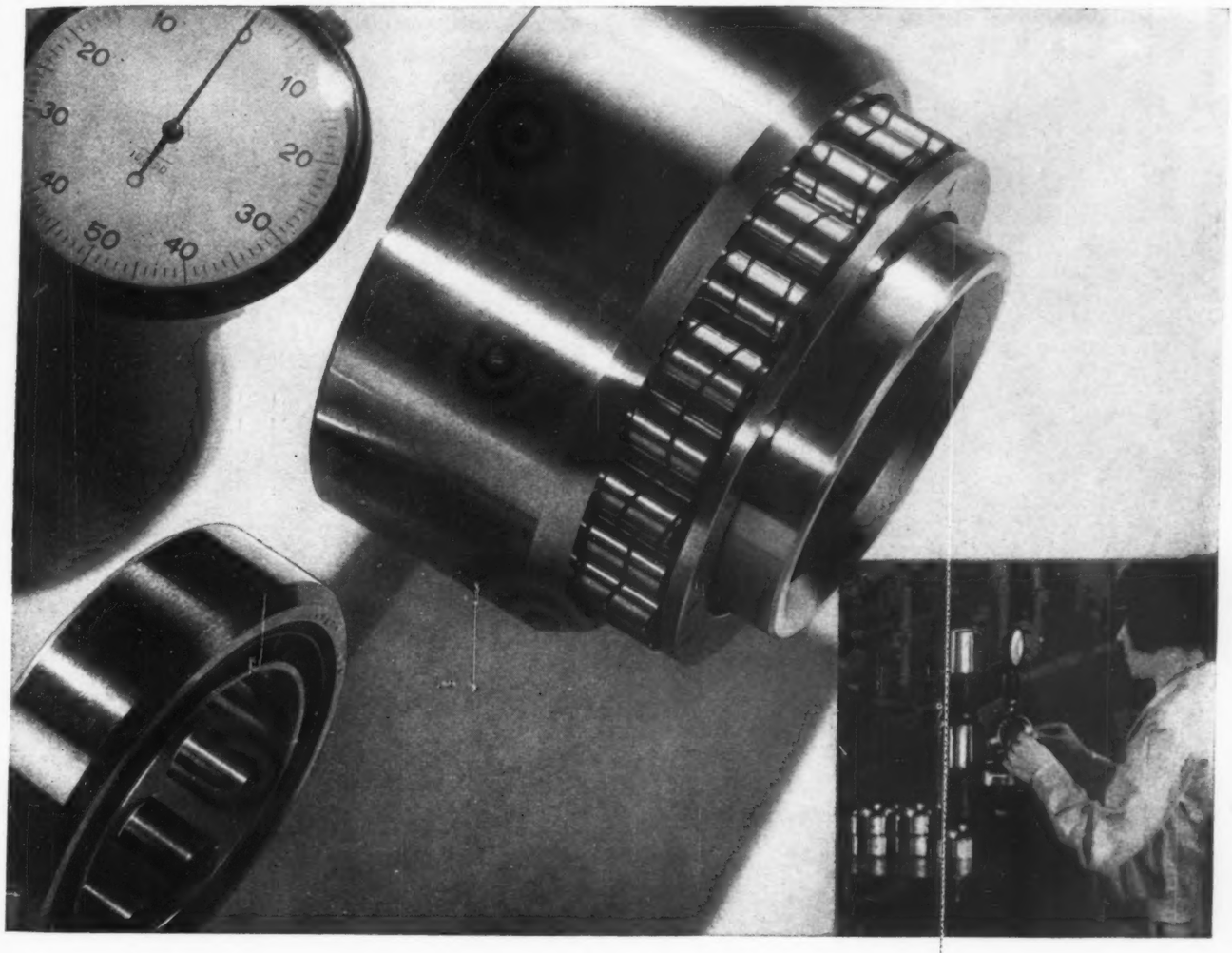
FRACTIONAL horsepower motors in a new line have been announced by Bodine Electric Co., 2264 West Ohio street, Chicago. The



Fractional horsepower motors may be secured with or without speed reducers

line includes type NSY-12 self-starting, single phase, synchronous motor in ratings of 1/75 horsepower in the open ventilated frame and 1/150 horsepower in the totally enclosed frame at a motor speed of 1800 revolutions per minute, and type NSI-12 induction motor in ratings

DEFINITE CONTROL OF QUALITY



The painstaking production and critical inspection of Hyatt Roller Bearings isn't done just to make them look bright and shiny. Hyatt quality is inbuilt so that they perform satisfactorily, last long and are economical to run in any service. Hyatt Roller Bearing Company, Newark, Detroit, Chicago, Pittsburgh, Oakland.

HYATT

ROLLER BEARINGS

PRODUCT OF GENERAL MOTORS

ALLEN

TRI-MARKT

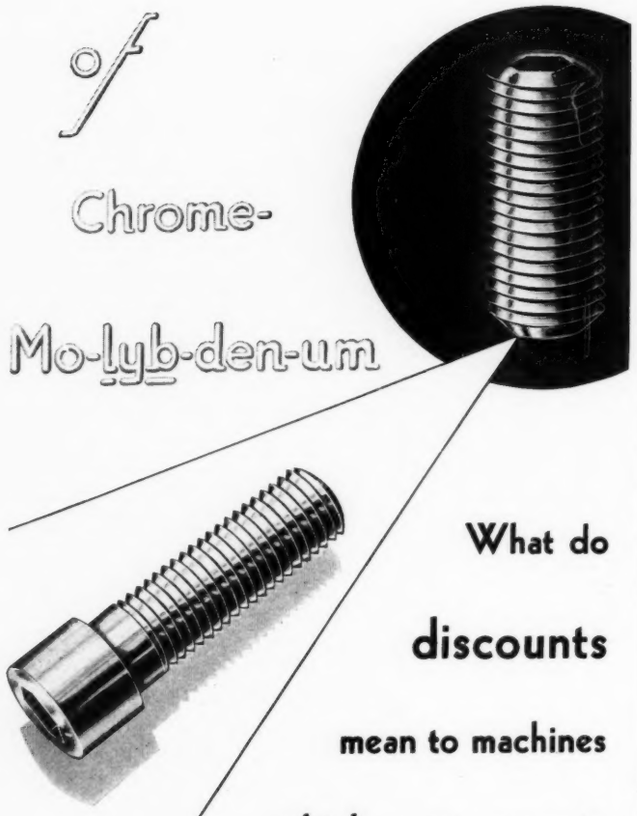
TRADE MARK

HOLLOW SCREWS

of

Chrome-

Mo-lyb-den-um



What do

discounts

mean to machines

which must operate

without breakdowns?

Designers, engineers, production men agree with ALLEN'S position on price—that "discounts hold no machines together" and it's smarter to buy a superior screw than to buy a superior discount. For a "shaded" price on your hollow screws, you soon buy trouble in the shop. Will you test some samples of trouble-proof screws if we'll send any sizes you specify? « « « «

THE ALLEN MFG. COMPANY

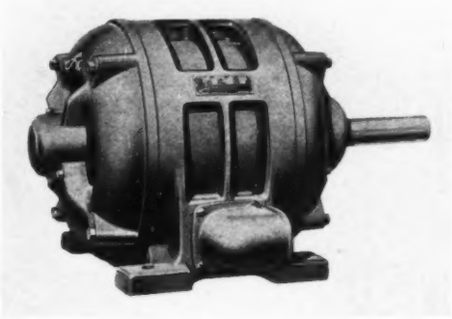
HARTFORD, CONN. U. S. A.

of 1/50 horsepower in the open frame and 1/70 in enclosed frame at a motor speed of 1125. Worm gearing in the following ratios is available in addition to other ratios available if required: 8½:1; 17:1; 30:1; 35:1; 72¼:1; 144½:1; 289:1; 595:1; and 1120:1.

The new motors are built with aluminum, die cast, three piece frames with separable gear heads and are finished in baked black enamel. Nitralloy steel shafts running in sealed ball bearings are used for the rotor with the worm gear cut on the shaft. Laminated bakelite gears are used in the speed reducer. The motor weighs 4½ pounds, has an overall length of 6-5/32 inches and a diameter of 3-21/64 inches. The slow speed drive shaft is 5/16-inch diameter.

Announces Rapid Reversing Motors

RAPID reversing squirrel cage motors, capable of as many as 60 reversals per minute continuously without overheating, have been



New motor is so designed that it may be versed rapidly without injury

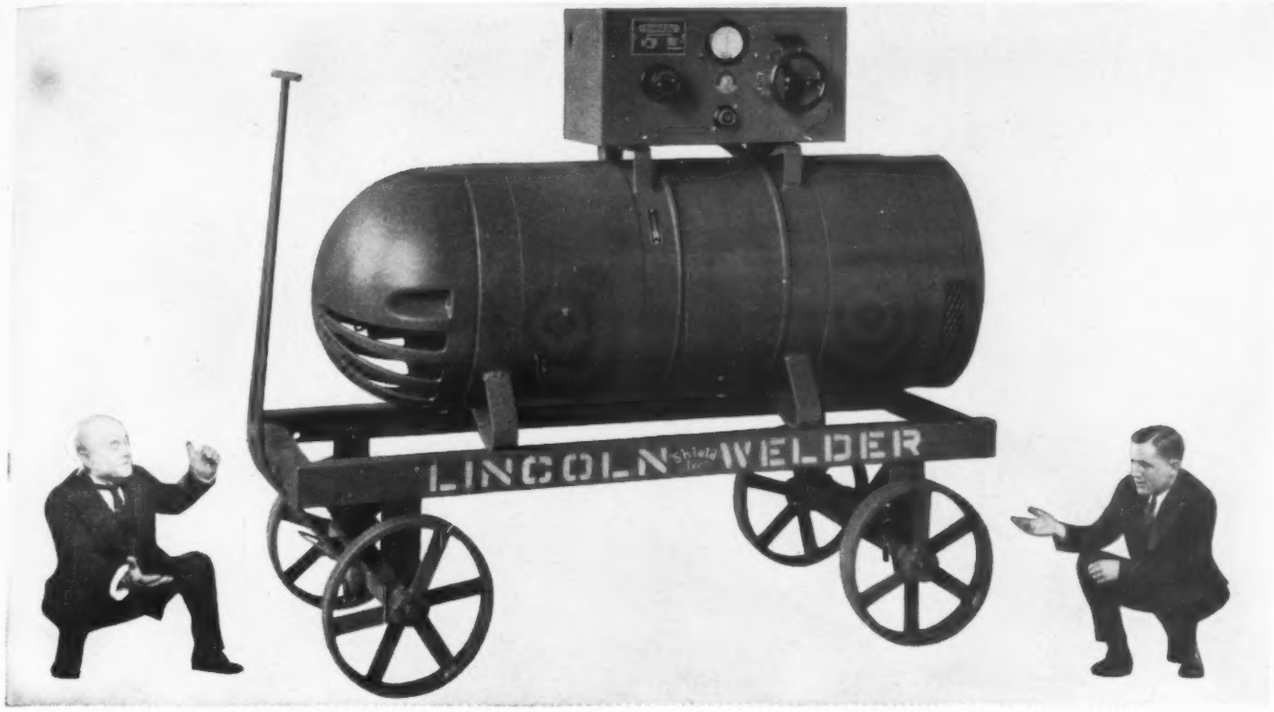
perfected by Louis Allis Co., Milwaukee. The rates of reversal have been made practical through light weight rotor construction, redesigned ventilation, high torque characteristics and shock resisting frames. The motors now are available for practically all machines that utilize fast reciprocating or reversing motions or require frequent stopping or starting.

The line includes the standard open ball bearing type and the rolled shell shaftless type, shown herewith. The motors are available in vertical, single speed, multi-speed, enclosed fan cooled and squirrel cage types. No auxiliary ventilation is needed in sizes up to 5 horsepower.

Pump and Motor Are Combined

SMALL general service centrifugal pumps ranging in capacities from 5 to 800 gallons per minute for heads up to 100 feet and in ¼ to 25 horsepower sizes are being offered by Inger-

POP AND LAD DISCOVER HOW TO SPEED UP WELDING . . .



"You slipped a fast one over on me when you put this new Lincoln *'Shield-Arc'* Welder to work.

"The weld production with the *'Shield-Arc'* is so much higher than that of the other welders that I thought something was phony until I investigated.

"I found that the uniformity of the *'Shield-Arc's'* welding current allows the operator to use a higher average current for any given size electrode. This makes the electrode melt faster with less splatter. Thus the operator can lay down more weld metal in less time with the *'Shield-Arc'*."

"If you'll check into the cost of welding, you'll find that the *'Shield-Arc's'* speed makes a whale of a difference—the difference between trading dollars and making a fair profit on present prices.

"With a few more *'Shield-Arc'* Welders we'll be all set to cash-in on the upswing of business.

"And we don't risk a penny when we buy *'Shield-Arc'* Welders because with them goes this Lincoln 3-Way Guarantee:

1. More weld metal deposit per K.W.H.
2. Faster welding per K.W.H.
3. Lower cost per unit of welding—the unit being per lineal foot of weld, or per pound of weld metal, or per hour of welding.

"Who can afford to buy a welder whose performance isn't definitely guaranteed?"

LINCOLN

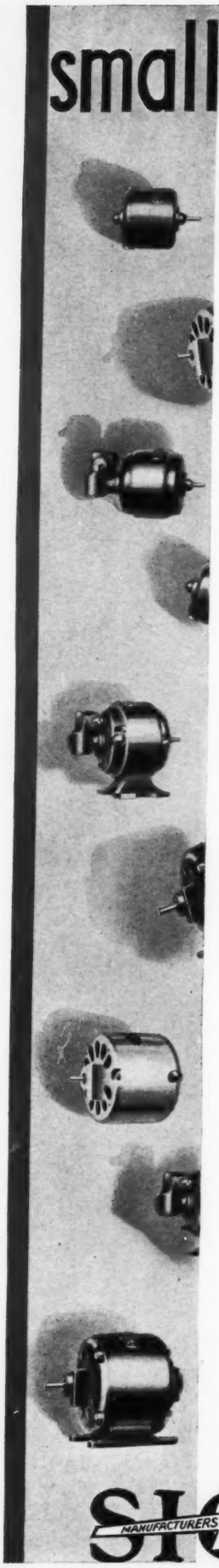
THE LINCOLN ELECTRIC COMPANY, CLEVELAND, OHIO

Largest Manufacturers of Arc Welding Equipment in the World

W-23

small MOTORS

designed to meet *your* Specific requirements



If the product you are designing or marketing requires a motor, make sure it is one that will give the utmost in satisfactory service » » » For the motor is the heart of every electrically driven machine or appliance.

Signal motors represent the highest in quality and efficiency because they are made for your individual needs. They are not stock types. » » » And the reason for their low price lies in the fact that the entire motor is made in the Signal factory.

Send us your specifications and we'll gladly send you complete information on Signal Fractional Horsepower motors made to meet your own specific requirements.

SIGNAL ELECTRIC MFG. CO.

Menominee, Michigan

SIGNAL

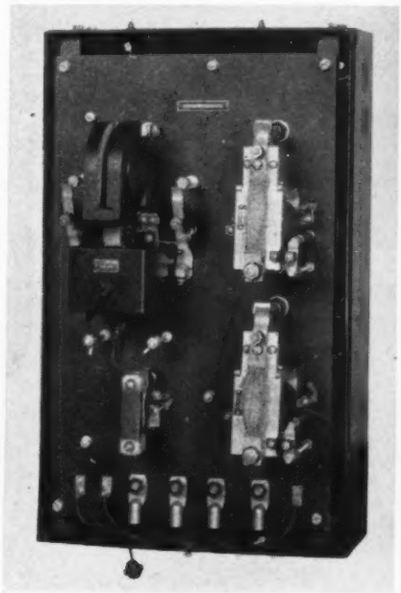
MANUFACTURERS OF ELECTRICAL PRODUCTS

soll-Rand Co., Phillipsburg, N. J. Both the pump and the electric motor which drives it are assembled as a single unit. No coupling or base plate is needed although the latter can be furnished if desired. The unit can be mounted upside down, vertically or in any other position. It has a single stuffing box and two bearings of the ball type.

Open type, totally enclosed or explosion proof motors can be furnished with the unit. It will handle practically all types of liquids.

Reduces Parts Required in Starters

GENERAL purpose mill type starters for constant speed direct current motors are a recent development of General Electric Co., Schenectady, N. Y. These starters, shown herewith, utilize newly developed accelerating contactors which have been designed to act not only in the capacity of a relay to provide time delay, but also to short out the starting resistor by means of a contact finger. The accelerating contactor, therefore, replaces two conventional devices, the accelerating relay and the old accelerating contactor.



Mill type starters use new accelerating contactors which replace two devices formerly employed

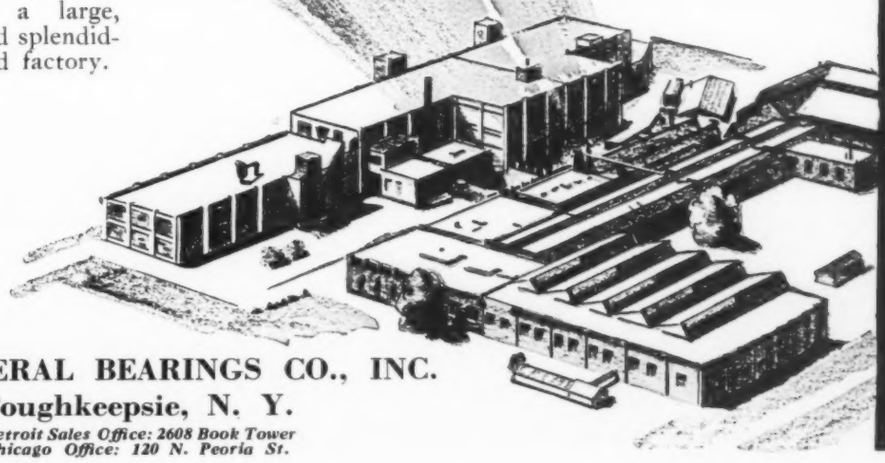
The new starters are sturdy and embody unusual mechanical and electrical simplicity. Accelerating contactors are equipped with silver faced tips so as to eliminate oxidation difficulties in instances where the motor operates steadily for long periods. The starters are available in sizes from 1 to 75 horsepower.

Instrument boards have been made less blinding for night motoring or night flying by illuminating luminous dials with invisible light beams, say engineers of the Westinghouse company.

FEDERAL BEARINGS

SELECTED by manufacturers in various industries who seek only the highest standards of ball bearing excellence. Neither time, money, or labor are spared to make "FEDERALS" the finest bearings that human skill can devise.

"FEDERALS" are made in a large, modern and splendidly equipped factory.



THE FEDERAL BEARINGS CO., INC.
Poughkeepsie, N. Y.
Detroit Sales Office: 2608 Book Tower
Chicago Office: 120 N. Peoria St.

A Pump For Every Purpose

ROPER

TRADE MARK REG. U.S. PAT. OFF. REG. IN CANADA

NO matter what the pumping job, there is a Roper that will handle it efficiently . . . with twin measures of dependable service and low-cost operation! Seventy-five years of experience stand behind every Roper pump; that's your assurance of satisfactory performance.

Fig. 1850 is representative of a line designed especially for machine tools. Types either with or without Automatic Relief Valve built into face plate.

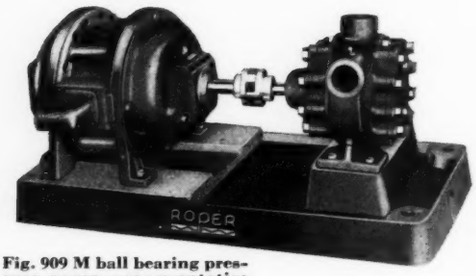


Fig. 909 M ball bearing pressure pump,—representative of a line for hydraulic power transmission. There is a type for every hydraulic duty up to 1,000 lbs. pressure.

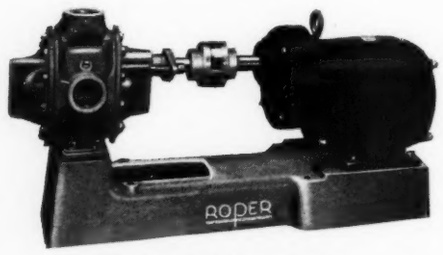


Fig. 3600 G H M is one of a series for bulk stations, refineries, etc. Designed for connection to geared-head motor. There is a type and size for any pumping job.

Mail coupon for Additional information!

Name_____

Company_____

Address_____

I am interested in pumps for_____

GEO. D. ROPER CORP.

430 Blackhawk Ave., Rockford, Ill.

MEN OF MACHINES

(Concluded from Page 46)

Inc., New York, as materials engineer. Prior to his service at the Bell laboratories, Mr. Marshall was in charge of the physical and mechanical laboratories of the Westinghouse Electric & Mfg. Co.

* * *

L. H. Morrison, for 11 years associate editor of *Power*, recently became editor of *Diesel Power*, published by Business Journals Inc.

* * *

John G. Wood is chief engineer, Olds Motor Works. He formerly was general manager of Muncie Products division of General Motors Corp.

Obituaries

FRED S. DUESENBERG, designer of early racing cars and creator of fine automobiles, is dead, the victim of an auto accident in Pennsylvania on July 26, last. Complications following injuries caused a relapse from which he never rallied.

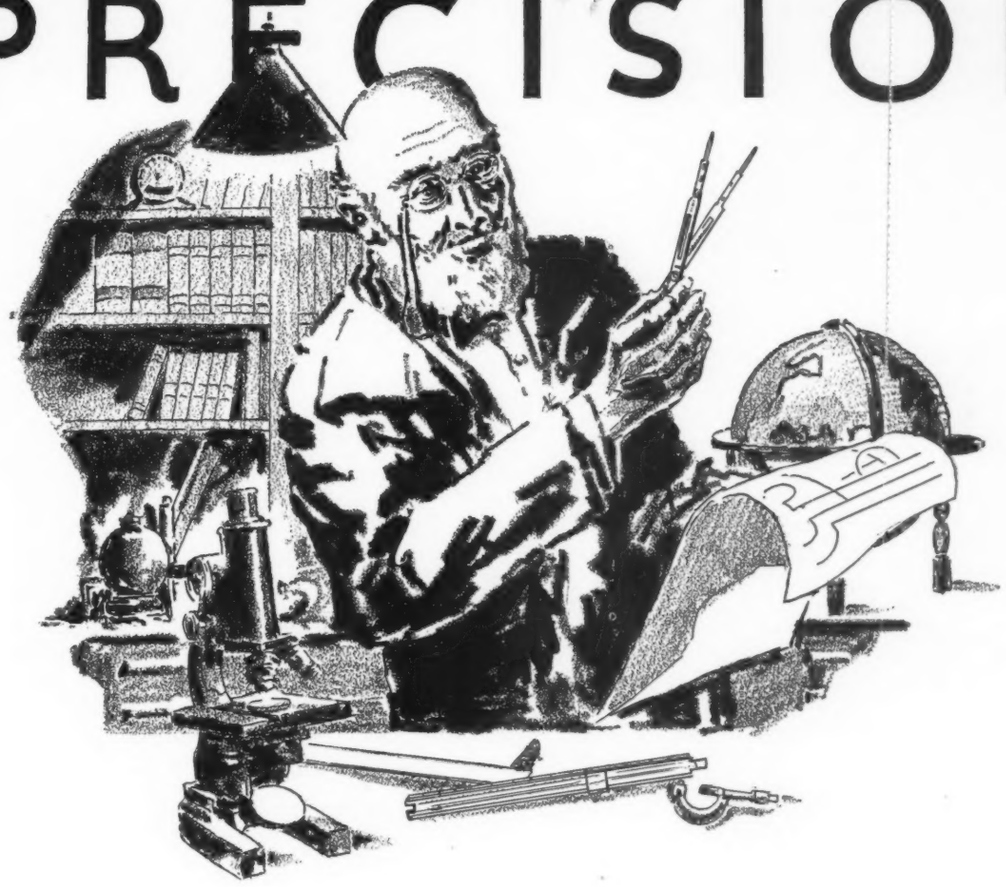
Born in Lippe, Germany, December 6, 1876, Duesenberg was brought to this country by his parents when he was four years old. Entering the automobile field as a racing driver and mechanic he developed a racing car according to his own ideas in 1910, and when in 1912 he entered a 230-cubic inch racer against a field of 450-cubic inch engines the brilliant performance of his machine upset many older engineering theories. This experience gave him a basis for the design of a line of six and eight cylinder engines later. Duesenberg Motors Corp. was formed in Indianapolis in 1917, control of the company subsequently being purchased by E. L. Cord in 1927.

* * *

Fred W. Sinram, prominent in the gear manufacturing industry, died August 3 in Cleveland, the place of his birth in 1881. He was president of Gears & Forgings Inc., and one of the founders of the American Gear Manufacturers' association which he served seven consecutive years as president and later as honorary president.

Graduating from the Cleveland Law school in 1903, Mr. Sinram shortly after began his business career with the Van Dorn & Dutton Co. In 1910 he was made secretary and in 1918 vice president. He was one of the founders of the Van Dorn Electric Tool Co.

PRECISION



BORN of the brains of technologists of the old school, to whom precision was a fetish » » » Evolutionized and refined to conform to advancing requirements of mechanical drawing. Such are

DIETZGEN DRAWING INSTRUMENTS

Discerning draftsmen instantly sense the scientific exactitude which these precision instruments place at their command » » » And can appreciate that their absolute accuracy . . . delicate balance . . . sturdy construction . . . easy adjustability . . . and standardized, interchangeable parts, are valuable assets to fine work and volume production » » » Now, to these indispensible elements, Dietzgen has added the new KROMET (Chromium) finish . . . to preserve the original, brand new appearance, and to simplify cleaning » » » The range of prices is agreeable . . . so for precision . . . value . . . durability . . . and long satisfaction . . . use DIETZGEN Drawing Instruments.

EUGENE DIETZGEN CO.

Enduring worth at reasonable cost

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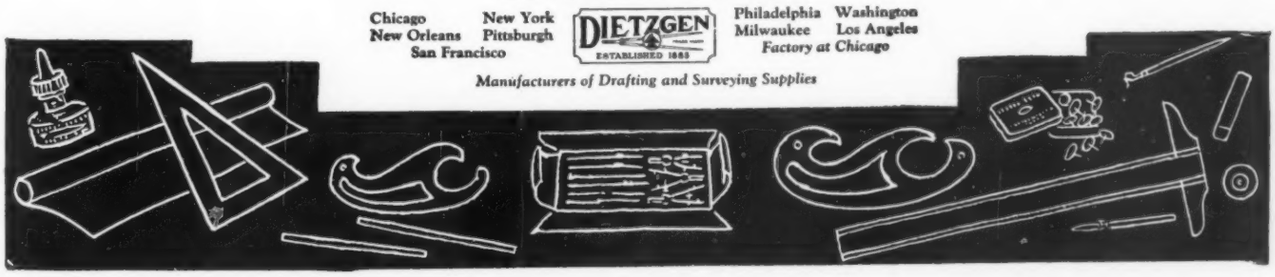
Manufacturers of Drafting and Surveying Supplies



Business and Sales Briefs

ROBINS CONVEYING BELT CO., with executive headquarters at 15 Park Row, New York, has appointed the following men in charge of recently opened sales offices: Cleveland, Robert Wisely, 229 Rockefeller building; Detroit, M. S. Lambert, 16170 La Salle boulevard; St. Louis, H. J. Martini, 7146 Dartmouth avenue; and Charleston, W. Va., R. U. Jackson, 905 Edgewood avenue. These offices are in addition to the branch offices in Pittsburgh, Philadelphia and Boston and the executive and sales offices in Chicago.

* * *

Wiley-Hughes Supply Co., Trenton, N. J., has been appointed by Detroit Seamless Steel Tubes Co. as an authorized distributor for Detroilined bushing stock in Trenton and surrounding territory.

* * *

C. C. Unlaub, 1712 Carter street, Dallas, Tex., is now representative of Magnetic Mfg. Co., Milwaukee, in that territory. Mr. Unlaub will handle the entire line which includes separators, clutches, conveyor rolls and other magnetic equipment.

* * *

Rawlplug Co. Inc., New York, has announced the appointment of C. K. Cairns Co., 119 East Fifth street, Cincinnati, as its representative in that district for the sale of fiber screw anchors, crowners, lok-crowners and other products of the company.

* * *

Foote Bros. Gear & Machine Co., Chicago, has appointed Urquhart Service, 2133 Blake street, Denver, as representative of its line of speed reducers and gears in Colorado and Wyoming. Briggs Schaffner, Winston-Salem, N. C., for several years local representative in the Winston-Salem territory was appointed recently as district representative for the states of North and South Carolina.

* * *

William R. Beck, who until recently was manager of sales engineering for Fort Pitt Steel Casting Co., McKeesport, Pa., now is sales manager for the iron and steel foundries of Atlantic Steel Foundry Co., Akron, O.

* * *

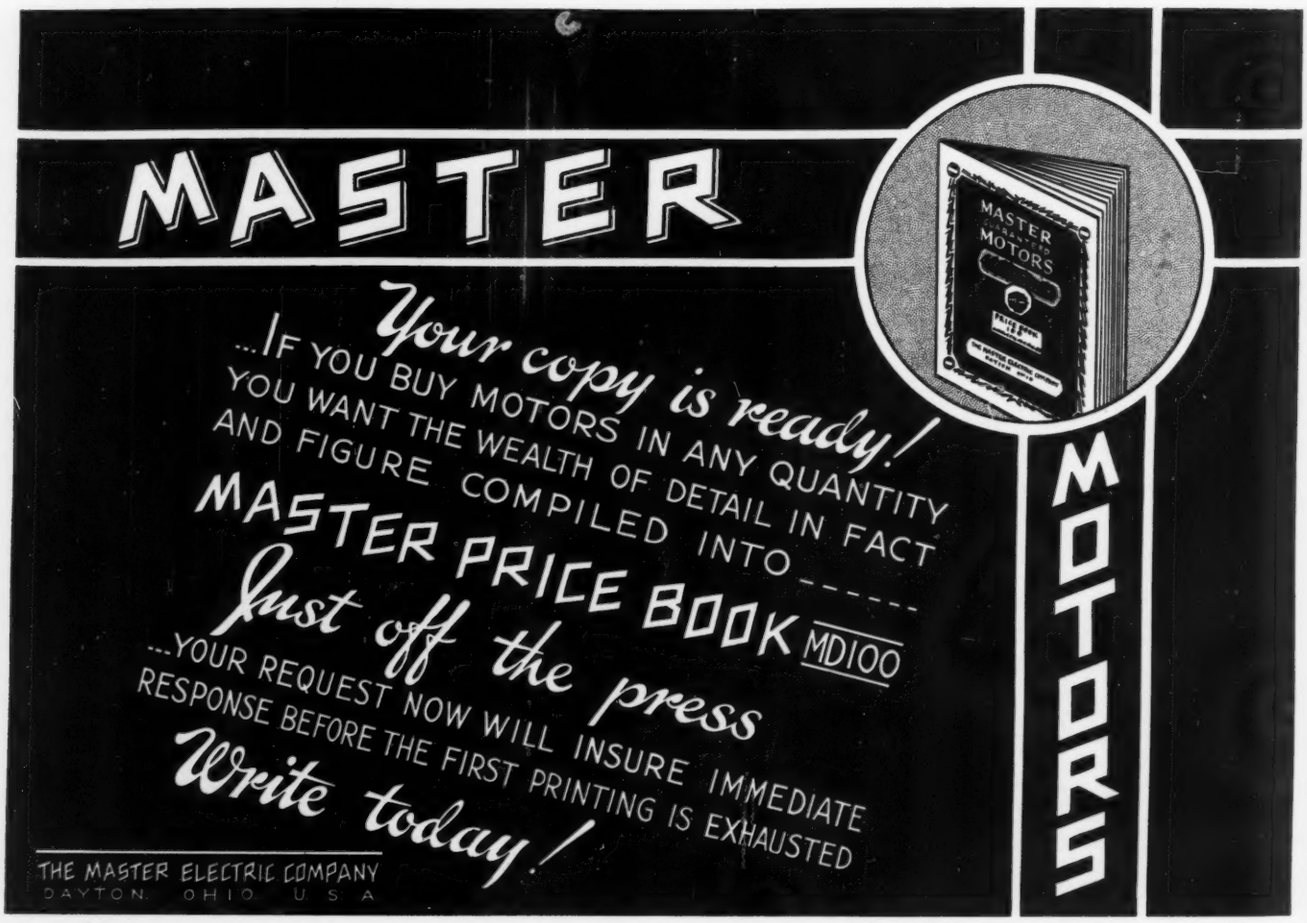
A. W. Schaefer, formerly associated with Pittsburgh Forgings Co., Pittsburgh, recently became connected with the sales force of Crosby Co., Buffalo, maker of sheet metal stampings.

* * *

Edgar T. Ward's Sons Co., with warehouses in Cleveland, Detroit, Chicago and Milwaukee, is now exclusive distributor in the central states for the mechanical seamless tubing manufactured by Timken Steel & Tube Co., Canton, O. The Timken company produces cold drawn mechanical tubing of both carbon and alloy steel in complete size ranges.

* * *

Harold E. Gray, former manager of sales in San Francisco for the Pacific Coast Steel Corp., subsidiary of the Bethlehem Steel Corp., has been appointed manager of sales for the company at Seattle. W. C. Scott Jr. will be his assistant. Russell W. Schultze, former manager of sales at Los Angeles, has been transferred to Portland in the same capacity, and Harvey Hewitt has been appointed manager of sales at Los Angeles. Mr. Hewitt was formerly manager of the bolt department of the Pacific corporation with headquarters in San Francisco.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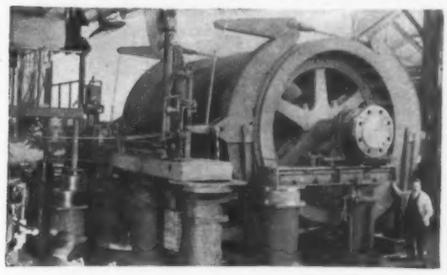
Close-up of SKF Bearing on motor coupling end.



4 BRUTES

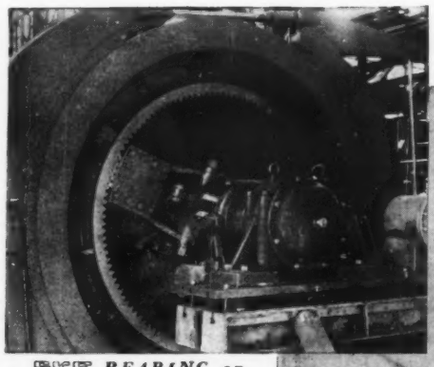
FOR UNFAILING HOIST PERFORMANCE

A giant job that calls for giant SKF Spherical Roller Bearings . . . to give smooth operation under severe working conditions demanding brute strength. That is the interesting story of why SKF Performance Takes Preference Over Price on this huge electric hoist built for the Lake Shore Mines by the Canadian Ingersoll-Rand Company ...and now operating successfully. The hoist, of the direct connected type, consists of two drums in line on a drum shaft. Each drum is 10 feet in diameter, 6 feet wide and weighs approximately 32 tons. The hoist is used for skip operation at the main shaft, hoisting ore from the 4200 foot level, and the maximum hoisting speed is 2000 feet per minute.

Four SKF Spherical Roller Bearings and Pillow Blocks are used on this hoist . . . the largest being nearly three feet in diameter. SKF Bearings reduce friction which is considerable when starting from rest and during acceleration, with consequent savings in power. The length of the entire machine is also reduced as SKF's are much shorter than ring oiling bearings generally used in hoists of this size. This factor permits reduction in length of the drum shaft and a decrease in the fleet angle of the rope as the drums are closer together, with consequent improvement in rope winding and reduced rope wear. **SKF** INDUSTRIES, INCORPORATED, 40 East 34th Street, New York, N. Y.

You may buy a bearing as a bargain but try and get a bargain out of using it, for nothing is apt to cost so much as a bearing that cost so little.

WHERE PERFORMANCE TAKES PREFERENCE OVER PRICE



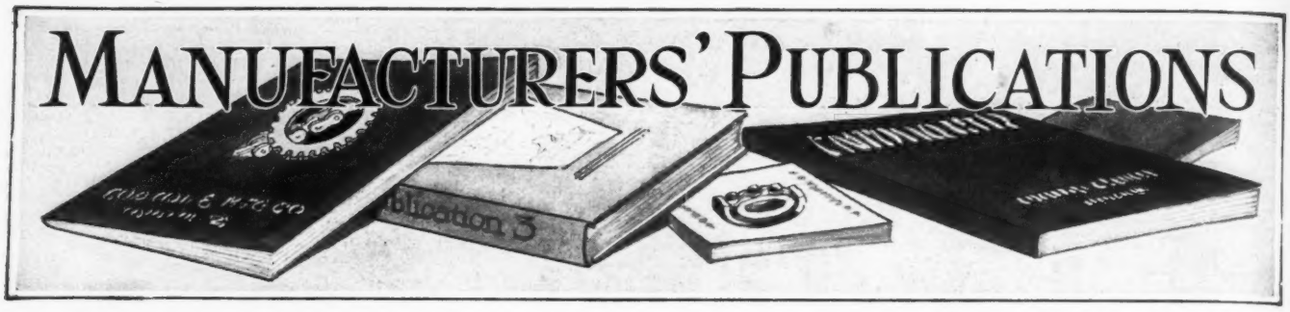
SKF BEARING on opposite end of hoist showing internal Expanding Jaw clutch.

FOUR SKF Spherical Roller Bearings and Pillow Blocks used on hoist with average height man for comparison of size.

SKF
BALL & ROLLER BEARINGS

2879

MANUFACTURERS' PUBLICATIONS



Publications listed in this section may be obtained by engineers responsible for design from the manufacturers of the products or through MACHINE DESIGN

BEARINGS—Horizontal mountings for thrust and journal bearings in small to medium sizes are presented in bulletin "S" of Kingsbury Machine Works Inc., Philadelphia. The standard shaft sizes for these mountings vary from 2 to 9 inches and the thrust bearing capacities from under 1000 to over 50,000 pounds.

BEARINGS—New Departure Mfg. Co., Bristol, Conn., has issued catalog insert No. 199 FE which deals with the application of ball bearings to a work head spindle for internal grinders. The entire development of the spindle bearings is presented in detail. Another recent publication of the company is a table of contents for the F. E. edition of inserts, revised to July, 1932.

BEARINGS—Dimensions and load rating tables of roller bearings manufactured by Hyatt Roller Bearing Co., Newark, N. J., and applications of the bearings are given in bulletin No. 100 of the company. The bulletin covers wound roller type bearings, solid roller type bearings, single row radial bearings and lubrication data. Considerable space is devoted to elements of bearing design, selection, load computation, assembly and similar information.

BEARING COMPENSATORS—Federal-Mogul Corp., Detroit, has prepared a pamphlet on the Wyromatic compensator, a device which provides constant adjustment of bearings and maintains this adjustment automatically. Preloaded springs in the compensator, which expand the parts and take up any wear or play in the bearing, may be varied to suit conditions and may be loaded up to 500 pounds if such preloading is desired.

DRIVES—Recent additions and improvements made in the line of speed reducers and transmission machinery manufactured by Winfield H. Smith, Springville, Erie Co., New York, are included in catalog No. 27 just issued by the company. Selection of speed reducers is simplified by the various types and capacities of reducers and by the tab system employed in indexing the book. Each piece of the equipment is described completely and tables give its size and producing ability.

DRIVES—Foote Bros. Gear & Machine Co., Chicago, has revised its No. 302 "Hygrade" worm gear speed reducer catalog. The new edition includes revised ratios and ratings for many of the different size units. Leak proof vertical worm gear reducers are an addition to the catalog.

DRIVES—Dayton Rubber Mfg. Co., Dayton, O., has issued a new leaflet on its line of cog belt drives with "Day-Steel" pulleys. The leaflet describes the drives and includes rating tables for two sizes of belts, covering horsepowers per belt from 0.6 to 2.2, center distances from 6.6 to 35.5 inches and motor speeds of 870, 1160 and 1750 revolutions per minute.

HYDRAULIC EQUIPMENT—Worthington Pump & Machinery Corp., Harrison, N. J., has prepared a catalog insert on hydraulic by-pass and check valves for automatic control of accumulator supply pumps. The sheet gives a complete description of the high and low pressure equipment and the manner in which they operate.

HYDRAULIC EQUIPMENT—Variable speed transmissions and variable stroke pumps as applied to all types of power plant equipment are presented in bulletin No. 121 of Waterbury Tool Co., Waterbury, Conn. The equipment is described and its operation is explained together with its proper application. Horsepowers, weights and dimensions are given.

MOTORS—Triumph Electric Corp., Cincinnati, has prepared a table of motor characteristics which may be applied for recommending correct types of motors for various applications. This table, printed on a card for convenient handling, includes motor performance for sizes from 1 to 100 horsepower.

MOTORS—Splash proof motors of squirrel cage induction types are covered in catalog insert GEA-1619 of General Electric Co., Schenectady, N. Y. The motors covered are for standard speeds and voltages, 50 degrees Cent. continuous operation, ½ to 75 horsepower. Another publication of the company is a folder on its line of squirrel cage motors. This folder covers the motors available and gives an outline of the capabilities of each.

RUBBER—B. F. Goodrich Co., Akron, O., has prepared a booklet giving considerable new information on hard rubber in sheet, rod and tubing form. The topics covered include the properties of the goods, resistance to chemicals, machining qualities, finish and tolerances, suggestions for machining and weights.

SPRINGS—A most comprehensive treatise on springs, wire forms and spring wires including much heretofore unpublished data has been published as a 48-page book entitled *Springs* by Wickwire Spencer Steel Co., New York. A set of helical spring design tables including over 2000 combinations of wire and coil diameter are included by means of which a helical spring may be designed without solution of the more complicated formulas. Calculations include a formula by which definite factors may be applied and a commercial tensile strength found for any type of spring wire. The book, which is exceptionally well prepared both from a technical and appearance standpoint. is devoted primarily to engineering data, tables and formulas.

WELDED PARTS AND EQUIPMENT—Materials handling methods recommended for welding departments and equipment to enable correct handling are covered in bulletin W-1 of Harnischfeger Corp., Milwaukee. The bulletin outlines the effect of improper and proper handling of the weld and shows the proper methods pictorially.